DOCUMENT RESUME

ED 321 401 EA 022 059

AUTHOR Clynes, Roger
TITLE Adaptability and Flexibility in Educational Facilities: Conclusions of a Seminar (Leicester, United Kingdom, June 19-22, 1989).
INSTITUTION Organisation for Economic Cooperation and Development, Paris (France). Programme on Educational Building.
REPORT NO SME-PEB-90.1
PUB DATE 90
NOTE 54p.
PUB TYPE Collected Works - Conference Proceedings (021) -- Reports - Evaluative/Feasibility (142)

EDRS PRICE MF01 Plus Postage. PC Not Available from EDRS.
DESCRIPTORS Adjustment (to Environment); Architectural Research; *Building Design; Building Innovation; *Building Plans; Construction (Process); Construction Costs; Construction Management; Design; *Educational Facilities Design; *Educational Facilities Planning; Elementary Secondary Education; Flexible Facilities; Foreign Countries; Physical Environment; Safety
IDENTIFIERS *United Kingdom

ABSTRACT

The development of adaptable and flexible educational buildings and facilities to support changes in educational systems is the subject of this report. A summary of a seminar sponsored by the Organisation for Economic Cooperation and Development (OECD) comprises the first part of this report. Issues discussed include the nature of change and implications for building design, cost, quality control, increasing people's awareness, and the building process. The second part presents a report based on a study of recent examples of developments in OECD member countries. Topics addressed include not only new building design, but also the adaptation and improvement of existing ones, health and safety considerations, cost and management issues, informational technological concerns, and environmental aspects. The appendices include a list of contributors to the seminar and addresses of OECD publications sources. (LMI)

****
* Reproductions supplied by EDRS are the best that can be made *
* from the original document. *
****

U.S. DEPARTMENT OF EDUCATION
Office of Educational Research and Improvement
EDUCATIONAL RESOURCES INFORMATION CENTER (ERIC)

☒ This document has been reproduced as received from the person or organization originating it.

☐ Minor changes have been made to improve reproduction quality.

• Points of view or opinions stated in this document do not necessarily represent official OERI position or policy.

"PERMISSION TO REPRODUCE THIS MATERIAL IN MICROFICHE ONLY HAS BEEN GRANTED BY

J. R. West

TO THE EDUCATIONAL RESOURCES INFORMATION CENTER (ERIC)."

EA 022 059

ORGANISATION FOR ECONOMIC
CO-OPERATION AND DEVELOPMENT

GENERAL DISTRIBUTION

Paris, April 1990

Decentralised Programme on
Educational Building

SME/PEB/90.1

Or. Eng.

ADAPTABILITY AND FLEXIBILITY IN EDUCATIONAL FACILITIES

Conclusions of a Seminar held in Leicester, United Kingdom
19-22 June 1989

by

Roger Clynes

Copyright OECD, 1990

Pursuant to article 1 of the Convention signed in Paris on 14th December, 1960, and which came into force on 30th September, 1961, the Organisation for Economic Co-operation and Development (OECD) shall promote policies designed:

- to achieve the highest sustainable economic growth and employment and a rising standard of living in Member countries, while maintaining financial stability, and thus to contribute to the development of the world economy;
- to contribute to sound economic expansion in Member as well as non-member countries in the process of economic development; and
- to contribute to the expansion of world trade on a multilateral, non-discriminatory basis in accordance with international obligations.

The Signatories of the Convention on the OECD are Austria, Belgium, Canada, Denmark, France, the Federal Republic of Germany, Greece, Iceland, Ireland, Italy, Luxembourg, the Netherlands, Norway, Portugal, Spain, Sweden, Switzerland, Turkey, the United Kingdom and the United States. The following countries acceded subsequently to this Convention (the dates are those on which the instruments of accession were deposited): Japan (28th April, 1964), Finland (28th January, 1969), Australia (7th June, 1971) and New Zealand (29th May, 1973).

The Socialist Federal Republic of Yugoslavia takes part in certain work of the OECD (agreement of 28th October, 1961).

The Programme on Educational Building (PEB) was established by the Council of the Organisation for Economic Co-operation and Development as from January 1972. Its present mandate expires at the end of 1987.

The main objectives of the Programme are:

— to facilitate the exchange of information and experience on aspects of educational building judged to be important by participating Member countries;
— to promote co-operation between such Member countries regarding the technical bases for improving the quality, speed and cost effectiveness of school construction.

The Programme functions within the Directorate for Social Affairs, Manpower and Education of the Organisation in accordance with the decisions of the Council of the Organisation, under the authority of the Secretary-General. It is directed by a Steering Committee of senior government officials, and financed by participating governments.

Publié en français sous le titre:

L'ADAPTABILITÉ ET LA FLEXIBILITÉ
DES BATIMENTS ET LOCAUX SCOLAIRES

THE OPINIONS EXPRESSED AND ARGUMENTS EMPLOYED
IN THIS PUBLICATION ARE THE RESPONSIBILITY OF THE AUTHOR AND
DO NOT NECESSARILY REPRESENT THOSE OF THE OECD

© OECD, 1990
Application for permission to reproduce or translate
all or part of this publication should be made to:
Head of Publications Service, OECD
2, rue André-Pascal, 75775 PARIS CEDEX 16, France.

As education changes to reflect the changing demands being made on it, so educational buildings have to be flexible and adaptable enough to support new methods, new curricula and new clienteles. Nowhere is this problem more acute than in the provision of specialist facilities - workshops, laboratories, and gymnasia for example - which are by nature both expensive to provide and designed for a specific purpose. In June 1989 delegates from fifteen OECD countries met at a seminar in Leicester, in the United Kingdom, to exchange views and ideas on how to ensure that good value was obtained from the provision of these specialised facilities.

The first part of this paper summarises the conclusions reached at the seminar, which was organised by the the OECD Programme on Educational Building (PEB) in association with the Department of Education and Science, Leicestershire County Council and Leicestershire Polytechnic. The second part reproduces a report on flexibility and adaptability in educational facilities which is based on a study of a number of examples of recent developments in OECD countries, and which formed the basis for discussion at the seminar.

The report considers not only the design of new buildings, but also the adaptation and improvement of existing ones; and in addition to architectural questions it looks at health and safety considerations, and cost and management issues. The author, Roger Clynes, was formerly Director of the Laboratories Investigation Unit and Superintending Architect at the Department of Education and Science in London. The views expressed in the paper are his own and do not commit the organisers of the seminar or the participants.

CONTENTS

PART ONE: SUMMARY OF CONCLUSIONS 5

PART TWO: THE BACKGROUND REPORT 11

1. INTRODUCTION 11
2. DEFINITIONS 12
3. TYPES OF TEACHING SPACE 13
   Characteristics of Specialised Facilities
4. FLEXIBILITY AND ADAPTABILITY 16
5. DESIGN STRATEGIES FOR NEW BUILDINGS 19
   Fully Adaptable Accommodation
   Less Comprehensive Adaptability
6. IMPROVING EXISTING BUILDINGS 28
   Free-standing Facilities
   Mobile Facilities
   Single Project Improvement
7. ENVIRONMENTAL ASPECTS 34
   Zoning
   Controls
   Adaptability of environmental systems
8. INFORMATION TECHNOLOGY (IT) 35
9. HEALTH AND SAFETY 39
10. MANAGEMENT 41
    Improving the use of existing accommodation
    Networking
    Is more Accommodation really needed?
    Improvement Projects
    Professional Advice
    Project Management
    Facilities Management
11. ECONOMIC CONSIDERATIONS 47

ANNEX: PAPERS DISTRIBUTED BY PARTICIPANTS 50

PART ONE: SUMMARY OF CONCLUSIONS

Adaptability and flexibility have been acknowledged as important concepts in the design of educational buildings for many years, but few recent buildings properly reflect this in their design. Why is this so, and what can be done to improve the situation?

Participants in a recent seminar organised by the Programme on Educational Building brought a range of expertise, experience and responsibility to bear on their attempts to answer this question. They confirmed that the need for adaptability and flexibility was greater than ever before, as the rate of change in education increases and the interactions between buildings and their users become more complex.

The topics covered by the working groups in their discussions were:

- the nature of the changes facing schools and colleges, and the extent to which they are predictable;
- the implications for building design of providing adaptability and flexibility;
- the cost of providing adaptability and flexibility;
- how to ensure that quality was maintained within a limited budget;
- how to raise awareness amongst the people concerned - architects, administrators, teachers and students - of the issues;
- how to ensure that adaptability and flexibility are not lost sight of in the process of building (or adaptation).

A problem of image

The starting point was to consider whether common perceptions of what is meant by adaptability and flexibility would explain why they are not more widely used. Until now architects have usually concentrated on technical solutions, or more frequently partial solutions, to making buildings adaptable. There can be several reasons why the adaptability thus provided has not been made use of:

- because the system was too difficult to operate;
- because it was too expensive to make changes;
- because the users were unaware of the building's potential;
- because administrative procedures inhibited such action.

Technical solutions often went hand in hand with system building of one sort or another. As a result the terms 'adaptability' and 'flexibility' have become debased, and are now synonymous with drab design and neglected buildings.

In a broader context this was not always the case. The English Georgian house is regarded as providing considerable flexibility, although it was not designed to that end. Its range of room sizes, their distribution and the simple method of construction has allowed a great variety of uses over the years. Moreover the buildings themselves, by virtue of their proportions and their detailing are thought to be anything but drab.

To take a very different example, a fundamental aim of the modern office building is to provide a high degree of adaptability, combined with a high quality of provision.

How then can the prejudice be overcome? One proposal for creating a more positive image was to drop the use of the words adaptability and flexibility and to find a new vocabulary; another was to devote greater effort to identifying and publicising examples of adaptable and flexible buildings which have been seen to be successful.

The predictability of change

Changes in the demands made on buildings could stem from educational change, but they could also be the result of a wider use of the facilities. Administrative and procedural changes could also have an effect. Some examples of the potential changes facing a school are given in the second part of this report. The way in which change can affect the building was provided by the School of Life Sciences at Leicester Polytechnic. During the relatively short time in which the accommodation had been in use:

- a teaching area had been turned over to research;
- two other spaces had been completely refurbished to meet new needs;
- major alterations to some spaces (which had been designed to accommodate them) were made once or twice a year;
- minor alterations - such as adding sinks, or moving mobile fume cupboards - took place monthly or even weekly.

The seminar drew the distinction between:

- revolutionary change, which is often imposed on a system and is generally difficult to deal with; and
- evolutionary change, which creeps into a system gradually and can more readily be taken care of.

The architectural implications

Discussion broadly confirmed many of the proposals made in the background report which follows this summary, including:

- the structure should be framed, kept simple and with regular spans (at least 6 metres between columns); unless land costs were prohibitive three should be the maximum number of floors; the load-bearing capacity throughout the building should be enough to meet the maximum requirements foreseen;

- the geometry of the building on the site should allow for 100% expansion horizontally; there should be a clear height of at least 3.5 metres to the underside of the structure;

- the core elements - e.g. lifts and staircases, ducts, toilets, plant room - should not be expected to change and should be designed to meet the standard required by all potential users. They should be positioned either in the centre or on the periphery of the building. Specialised support spaces should be similarly sited;

- The planning grid should be within the range 1.2 to 1.5 metres and consistent with the structure and window spacing;

- four to six categories of space type should be provided - say 20-30m^2; 60m^2; 90m^2 and specific large spaces;

- the service infrastructure should be on a grid consistent with that of the structure. The design should allow for a possible doubling of capacity. Major service routes should have access that does not disrupt educational activity.

Costs

There was general agreement that that cost of providing adaptability and flexibility should be considered in the context of an assessment of the lifetime costs of a building. In this way the benefits of adaptability could be taken account of at the stage of initial cost planning. There was however disagreement on whether providing adaptability was bound to be more expensive than not doing so. The answer may depend to some extent on the type of building in question. In one example from the United Kingdom two new primary schools were compared. The one, of traditional construction, cost considerably more than the other, which was not only highly adaptable, but larger. However in a more complex, more highly serviced type of building some aspects of adaptability - such as the deliberate over-provision of floor loading capacity to allow for future unknown requirements - will inevitably cost more in the short term, even though the future benefit may be considerable. In another

example these higher cost elements were balanced out by below-average costs in other areas so that the total cost of the building was no more than that for comparable accommodation of fixed design.

Quality and Image

There was felt to be increasing pressure for buildings both to be of high quality and to be seen to be so. The image that a building conveys to potential 'customers' was in some countries becoming as important for educational establishments as it is for more traditionally commercial concerns. There is nothing implicit in adaptability and flexibility which militates against quality, despite the poor impression created by some earlier system-built examples; indeed the 'high-tech' appearance of some adaptable buildings could be turned to considerable advantage.

People

It was generally agreed that it was essential to raise the awareness, understanding and acceptability of what is meant by adaptability and flexibility amongst architects, politicians, administrators and users (especially headteachers) of educational buildings.

One way to do this would be to carry out case-studies which demonstrate the educational and the long-term economic advantages of adaptability and flexibility through documenting actual changes of use and running costs over a period of time. The chief difficulty in this is simply to obtain the necessary factual information. That which is available from existing meters (for electricity and gas, for example) may not be sufficient to make valid comparisons; or the initial construction and installation costs of a building may not be broken down in the sort of detail necessary. For information on the cost aspects it might also be possible to draw parallels with examples drawn from fields other than education.

The methods available for drawing attention to the material thus collected include:

- publicity material such as newsletters, and articles in the technical and educational press;
- interactive video or computer simulations, based on real or theoretical examples;
- seminars;
- study visits;

The approach adopted will depend on local circumstances and the nature of the target audience.

The briefing and design process

The seminar concentrated a good deal of attention on the process by which new buildings, or improvements to existing buildings, are made. There was general agreement on the importance of appropriate briefing, although there was some divergence of view on how some aspects of it should be carried out, in particular as to the necessity of appointing architects on the basis of competition.

The traditional method of briefing can be seen as linear and sequential, leading to the completion of the building or project, and its handover to a client who makes of it what he will. A precise brief is formulated from an agreed programme of needs, following which a design is prepared. Early in this process the possibility of making changes has virtually disappeared, even if new needs become apparent. Too often the result is a good solution to the wrong problem.

The alternative approach allows for a more continuous dialogue between the various parties involved in which discussion and compromise lead to an effective solution. Users have to be brought into discussions early, and the architects have to be available after handover to advise users on using the building to its full potential. In the case of a new building where the future users are unknown their point of view must be simulated by others who are able to play their role. Such a briefing process is inevitably more time-consuming and more complex than the traditional one but the benefits it will bring in terms of appropriateness of provision are considerable.

Follow-up

In order to build on the progress made at the seminar, participants recommended the following action:

- The findings of the seminar, together with the background report, should be made available to a wide audience. This report fulfils that remit.
- Individual participants should report back to their places of work and should make use in their day-to-day tasks of the insights gained at the seminar.
- Within countries participating in the Programme on Educational Building:
  - information on selected aspects of adaptability and flexibility in practice should be made available to the PEB Secretariat for wider dissemination;
  - work should start on creating a dossier of existing examples of adaptability and flexibility;
  - long-term studies should be undertaken of the total costs of a range of different educational building projects over time. PEB could publish the eventual results;

- a list of people (architects, administrators, users and others) who have practical experience in this area and who are willing to act as a resource for others should be drawn up.

PART TWO: THE BACKGROUND REPORT

1. INTRODUCTION

It is increasingly accepted that many building types need to be designed to allow for future change: change that is invariably unpredictable and often radical and required to be carried out quickly.

In educational buildings such changes may result from:

- changes in the age at which pupils leave school
- demographic changes, local or national
- the rationalisation or reorganisation of school provision in a locality
- increased participation rates and new clienteles, in non-compulsory sectors
- the creation of new fields of study, or a changed balance between existing disciplines
- changes in teaching and learning methods, and in particular the introduction of new educational technology
- changes in the size of teaching groups.

Some of these changes may occur once only, such as the first above. Others, such as the last, may vary on a short term basis while yet others will be longer term.

Appropriate design allows the users of a school or college to meet many changing needs themselves. However, many educational buildings have not been designed so that changes can be carried out easily, and few of those that were so designed have in fact been adapted in the way that was intended. By contrast there are other buildings, often in sectors other than primary and secondary education, where in-built responsiveness has been utilised considerably.

Where specialised facilities are concerned it is particularly important to take adaptability and flexibility into account. Specialised facilities are more expensive to provide than are non-specialised ones; and the more fixed they are in design, the lower will be their utilisation rate. Furthermore when changes are required, they will be expensive to carry through unless appropriate adaptability has beenprovided.

This paper will suggest ways and means whereby adaptability and flexibility can be provided for specialised facilities in both new buildings and existing ones. It will also discuss some of the management issues that arise if the best use is to be made of facilities designed in this way.

2. DEFINITIONS

The terms adaptability and flexibility are frequently used loosely and interchangeably . Often this lack of clarity does not matter as the meaning in any particular case is clear enough. However when considering the ability of a building, or a part of one, to be responsive to the changing requirements of what goes on inside it, then more precise definitions are required. This is because two different concepts are involved. Neither is new and by now considerable experience has been gained in some fields by designers and building users of what they imply in practice.

The definitions used in the 1976 OECD publication 'Providing for Future Change: Adaptability and Flexibility in School Building' are:

> ***Adaptability*** *- the quality of a building which facilitates adaptation; adaptation may require relocation, replacement, removal or addition of the constructional elements, the services, or the finishes of the building. This is essentially large magnitude/low frequency change.*
>
> ***Flexibility*** *- the quality of a building which permits variations in activities, timetabling, class size, and methods of work without the need for adaptation as defined. This is essentially low magnitude/high frequency change.*

3. TYPES OF TEACHING SPACE

Teaching spaces can be characterised by their size, their furniture and equipment requirements, and the demand they make on services (gas, water, electricity).

In the past teaching spaces in schools and colleges could be broadly classified as:

- standard classrooms

  these were unserviced and were often allocated on a departmental basis; in some colleges the classrooms might all be grouped together in a separate block;

- dedicated single-function spaces

  some of these were very specific in the way they were fitted out, for example language laboratories and car maintenance workshops. Others actually had similar facilities one to another but were distinguished only in terms of 'the name on the door'. Many of the rooms had a fixed arrangement of furniture and equipment. They were often occupied for only a limited number of hours per week.

More recently there has been a shift away from this approach. Classrooms have in many cases become a shared resource of the whole institution. It is better for them to be dispersed so that they can be used in conjunction with other teaching spaces. The proportion of basic standard classrooms is likely to drop as the need for information technology facilities becomes greater throughout the school or college.

In some fields the single-function spaces are giving way to multi-function spaces which can offer a more integrated learning mode; they are normally required to house a range of furniture and equipment. Examples include:

- an adaptable training kitchen in which a range of types of work can be simulated;

- a multi-discipline laboratory suitable for physics, chemistry and biology work.

This shift has occurred for two reasons:

a. it provides a learning environment that is similar to what students will find in the commercial world; for example a 'training office' for business and office studies rather than separate typing and computer rooms.

b. it allows more intensive use of space: the classrooms because they are available to all; and the multi-function spaces since they are fitted out for a wider range of work.

- **The aim should be to provide multi-function space rather than dedicated single-function space wherever it is appropriate and possible to do so.**

Characteristics of Specialised Facilities

There is a general distinction between rooms which are 'normal' in terms of their ceiling heights and services provision but which become 'specialist' when housing special equipment or furniture, and spaces which have specific spatial requirements: examples are sports halls, drama studios, music performance studios, and lecture theatres.

Another way of classifying specialised facilities is into two categories of Light Practical and Heavy Practical. Some examples of each and their main requirements are set out below. They are based on experience in the United Kingdom; the requirements for teaching and learning may be different in other countries.

Light Practical

All of these will require at least low power electrical supply.

Humanities

- space for addressing up to 60 pupils;
- languages consoles for sub-divisions of a class;
- facilities for using tape and records;
- work in geography will involve model making and map-work, and will require access to laboratory-type facilities for demonstration and study.

Business and Office Studies, Computing, Mathematics

- a main concern is how to get cables to the work places without having dangerous cable runs or fixed layouts ofequipment;
- Mathematics increasingly involves practical work such as model making;

Science, Home Economics

- electrical, water and gas supply; drainage; fume cupboards for chemistry work are all required.
- there is still an emphasis on the individual sciences although general or integrated science work may predominate at certain levels;
- for Home Economics there is a change of focus towards home and life studies from cooking skills and the like;

Craft, Design, Technology (CDT)

This has evolved from traditional crafts work. It involves 'design and make', technology, and communication.

- a wide range of activities using a variety of materials take place often in a single, large working area; both fixed and free-standing equipment are needed.

Heavy Practical

Traditional wood, metal and electrical work and building construction require:

- workshop facilities broadly similar to those of a light engineering factory;
- 3-phase electrical supply; mechanical ventilation; dust and fume extraction for specific items of equipment;
- fume extraction (particularly important for vehicle maintenance work); access for cars and other vehicles is also necessary.

Teaching Kitchens

- a range of kitchen layouts to simulate traditional, fast food and other arrangements;
- a variety of related service layouts;
- associated dining space.

4. FLEXIBILITY AND ADAPTABILITY

The basic difference between these two approaches is that for flexibility over time, the likely changes in use (and their requirements) must be broadly predicted at design stage. In some fields this will be easier than in others. Moreover the introduction of new instrumentation and equipment, economic factors, or in some cases fashion, can change requirements in quite unpredictable ways. The building must therefore be so designed and fitted out that different types of work and new ways of working can be adequately accommodated. This means designing for a common denominator of likely requirements; not only in terms of room sizes but also taking account of likely future needs in respect of floor loadings, clear spans, room heights and servicing provision.

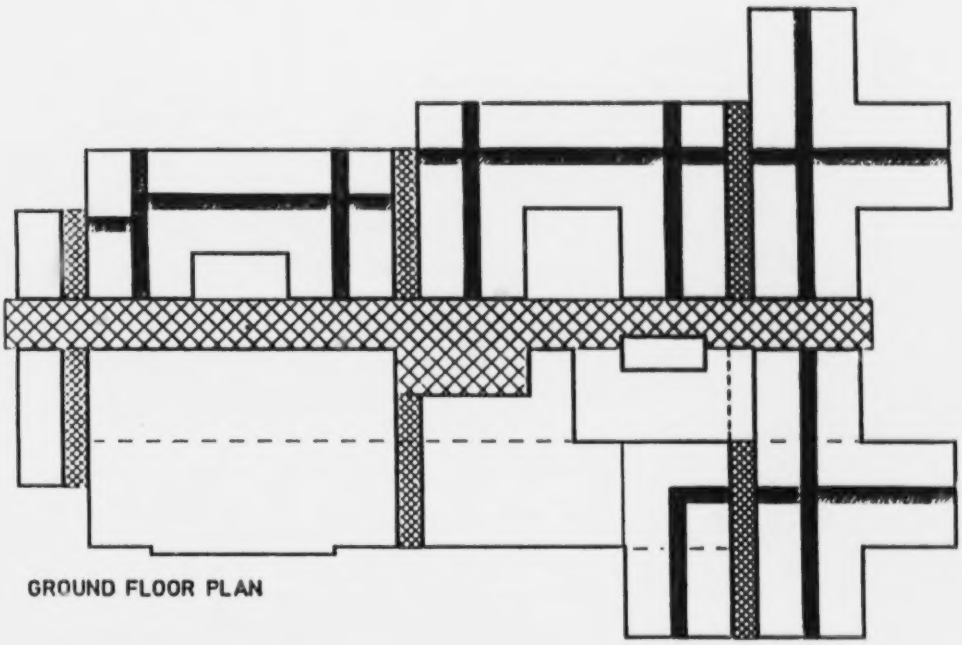
In the case of adaptability the approach is different. Here changes are met by different degrees of alteration to the building and its fittings to give an arrangement which meets the specific needs of the current use. At the simplest level this may mean that room layouts need to be changed. If the fitting out is appropriate this can be done in a very short time by the school or college staff themselves. At the other extreme, spaces may change their size and function - involving the removal or addition of partitions, additions to or re-routing of services, or the incorporation of new equipment. Depending upon the scale of work to be carried out, this too may be done by support staff of the institution if they have been trained for it or alternatively by an outside contractor.

Between these two extremes, a range of alterations can be made as and when required. It would be prudent for a modest stock of spare components to be kept. In practice best advantage is gained by combining flexibility and adaptability in the design of a building. However the emphasis may well lean towards one of the approaches more than the other.

An example of broad long term flexibility of use can be seen in the design for Leith Academy in Lothian, Scotland. Here a large, single building is being provided to bring together the facilities at present situated in the main school building and various annexes. Furthermore the new one will be a community school which will accept adults who will study together with pupils in the full spread of class work. It will also provide social facilities to be shared between the school and people living nearby. Over the life of this building pupil numbers are likely to fluctuate. The design for Leith Academy therefore allows both for expansion (up to 40%) and radical contraction if educational demand should so dictate (Figure 1).

The accommodation is sub-divided by three types of circulation: a wide main mall running the full length of the building; secondary circulation routes at right angles to the mall, each giving access to the departments on either side of it; and thirdly, local circulation within each zone of the building. Each zone can thus be used independently. Also, if student numbers drop appreciably below those designed for, then one or more of the zones can be rented out for such use as a health centre, a commercial or light industrial unit. The distribution of services follows a similar pattern to that of the circulation. The heating and ventilation is zoned in accordance with the planning zones.

Figure 1: Leith Academy - floor plans



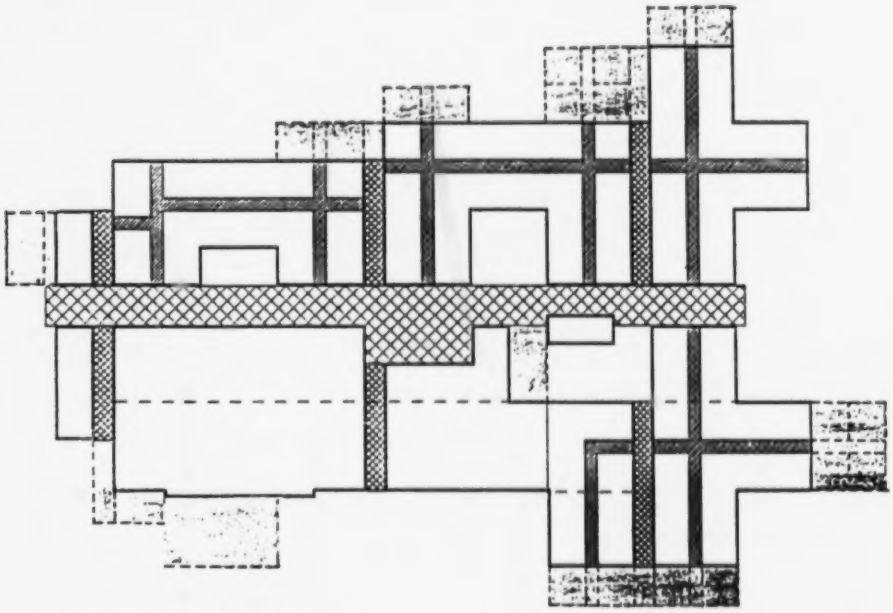
GROUND FLOOR PLAN

CIRCULATION ROUTES

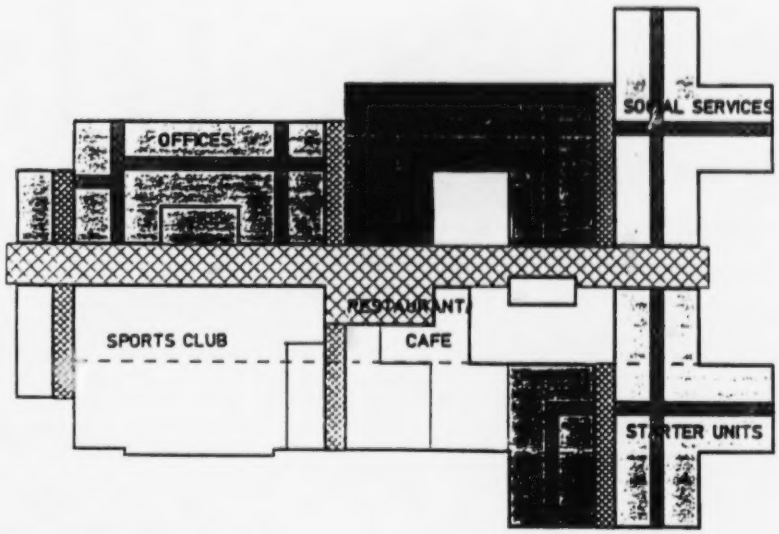
PRIMARY

SECONDARY

TERTIARY



EXPANSION STRATEGY



RADICAL CONTRACTION

SHOWING BLOCKS WHICH COULD POTENTIALLY BE IN SEPARATE OCCUPANCIES

5. DESIGN STRATEGIES FOR NEW BUILDINGS

When designing accommodation for a whole institution, an overall strategic plan must be devised. Each solution will have its own advantages and disadvantages. The solutions will range from a 'village' consisting of a series of separate blocks, to a single self-contained building in which everything is provided.

Separate Blocks

The advantages of the block by block approach can be summarised as follows:

- flexibility in the construction itself, as finance (and possibly land) becomes available;
- flexibility of design - detailed changes to one block can be dealt with at a relatively late stage without other blocks being affected;
- flexibility of Management - individual blocks can be opened for special use;
- the degree of adaptability to be provided can vary from one block to another;
- planning and structural grids can vary between blocks if necessary;
- different approaches can be taken for the servicing of each block;
- individual blocks can be extended provided original design makes proper allowance for this; and
- as student numbers change, individual blocks can be given up to other uses or be taken over again.

Possible disadvantages are:

- the institution may be more spread out and less easy for users to relate to as a whole;
- pupils and staff may have to move from block to block in all weathers, which could be severe in some climates;
- conversely, pupils may be inhibited from making full use of the range of facilities provided in other blocks.

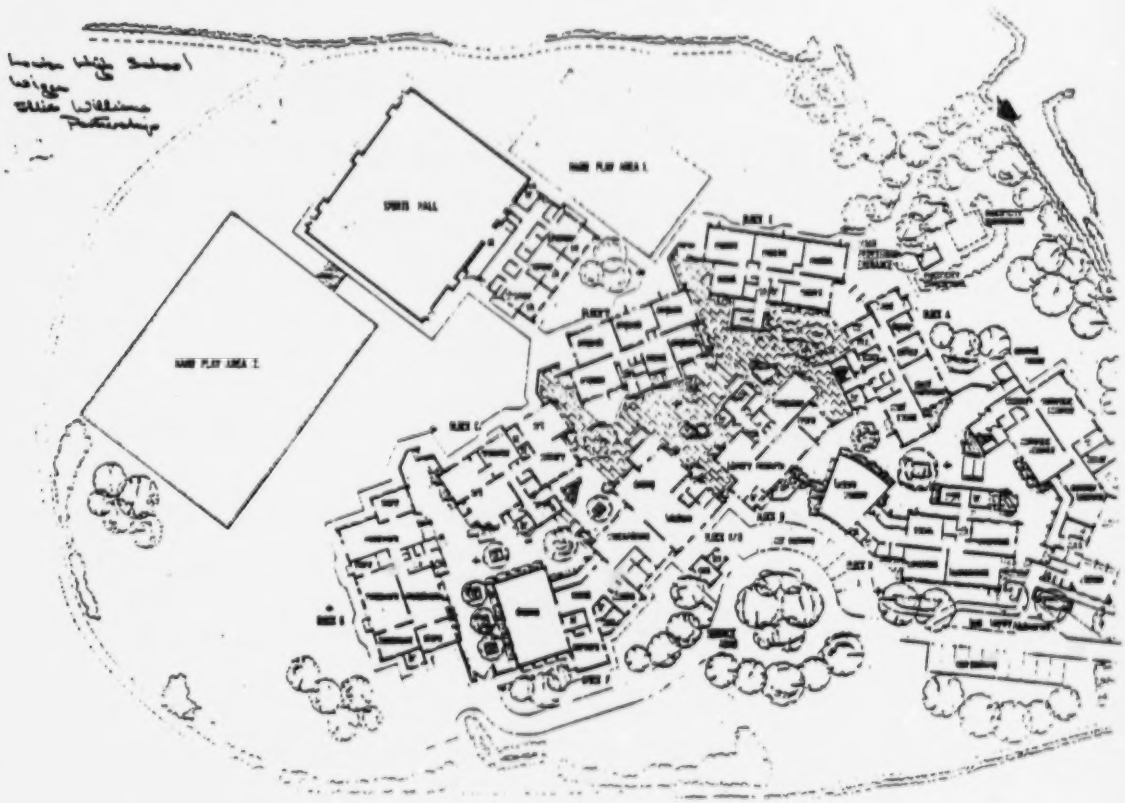
Single Building

The advantages and disadvantages of the single building tend to be the converse of those outlined above. They will however be affected by the actual size of the building. With a very large single building, circulation within it will have to be very clearly organised for there to be a 'sense of place' throughout. Where the building is

less large, then the homogeneity can more easily give the users a sense of belonging. Finally the positioning of the more highly serviced areas will have to be carefully considered so that main and secondary service runs are not unduly extended.

Lowton High School, Wigan, England is an example of separate blocks together on one site (Figure 2). It was initially designed for 750 pupils but the numbers were increased to 900 before construction work began. The design approach enabled new blocks to be added and others to be changed without affecting the overall scheme. Each block houses a faculty and has a serviced area for shared use by different groups of students. Some blocks are interlinked at high level. This has allowed the science faculty easily to expand into converted adjacent teaching space and into one of the shared serviced areas. The bridge acts as a common preparation room. Similarly, CDT has expanded, sharing a space with art in the block next to it. The general teaching space taken over during this rearrangement was displaced elsewhere; some work provided by filling in an open area in one of the other blocks.

Figure 2: Lowton High School



Another example of the dispersed block approach is the Victoria Community Centre and High School, Crewe, England which is housed in four separate units, each providing joint educational and community features. These form a chain across the centre of the town linking the school to the existing public cultural facilities. One advantage of this arrangement is that these joint facilities are accessible to more people than would have been the case if they were concentrated in one place. Another advantage is that smaller scale buildings could be designed.

Paradoxically, a design that may appear on paper to have clarity and clear logic in its planning may in practice be monotonous or oppressive. By contrast a building with a human scale and a range of spaces of character may seem to be muddled in two dimensions. Hence the need for close collaboration and mutual understanding between client, users and designers so that the full implications of a design are understood before it becomes settled (this point is further discussed in Section 9).

In any case the provision of flexibility and adaptability does not have to imply a building interior that is bland and dull in appearance. The so-called 'all-purpose shell' (sometimes known as a 'no-purpose hell')is not what is required.

Fully Adaptable Accommodation

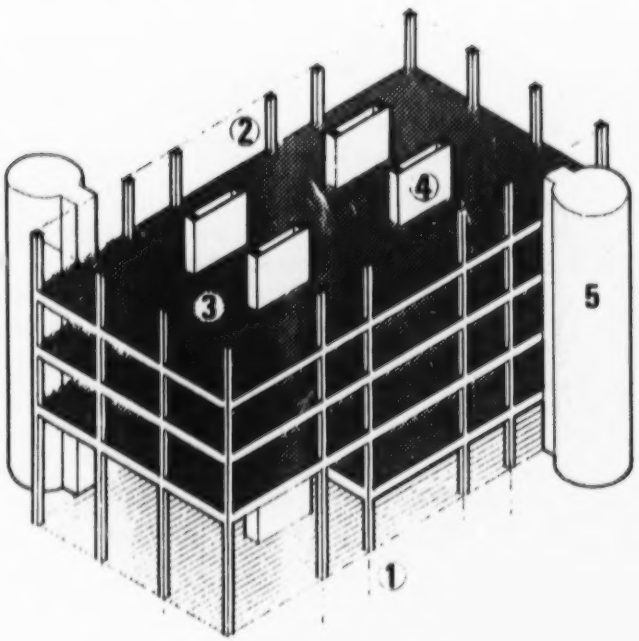
This concept was developed particularly for laboratory buildings, which include laboratories of all types together with their associated back-up facilities. The approach is nevertheless valid for other types of specialised accommodation. It distinguishes between:

a. the basic parts of a building which can be designed to be suitable for a range of broad uses and therefore need not change; and

b. the supplementary parts, the arrangements of which will vary between the more precise needs of different activities; they should therefore be designed to be changeable .

- **The design strategy which emerges is to have a flexible basic building 'shell' which will meet those requirements common to all potential users. This is then planned and fitted out in individual areas with adaptable elements to meet the needs of particular user groups. These adaptable elements can be re-located in the future as teaching and learning programmes develop and demand for the disposition and layout of spaces changes (Figures 3 and 4).**

Figure 3: Fixed structure



CHANGE PREDICTION

never
60 yr + fixed

1 foundations

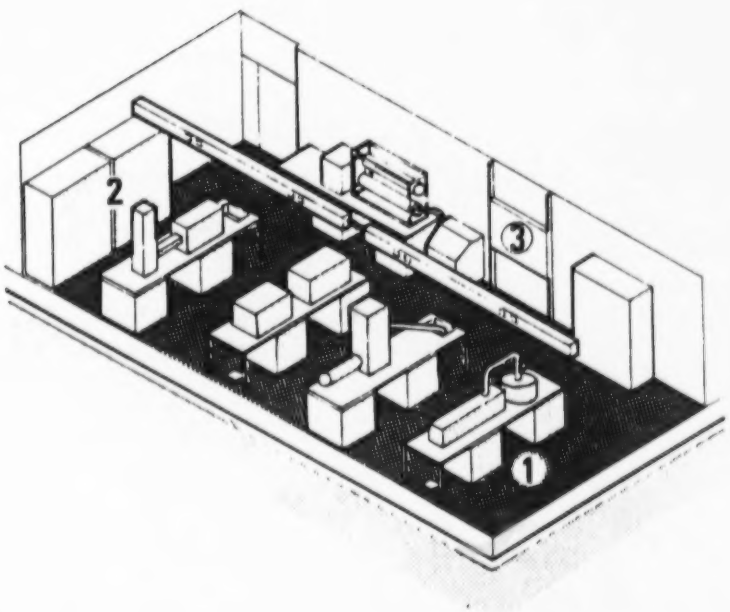
2 columns

3 floors

4 vertical ducts

5 vertical circulation

Figure 4: Adaptable equipment



CHANGE PREDICTION

frequent / often 0-3yrs

1 bench

2 storage

3 display

Planning

When designing for adaptability a regular module should be used as a planning discipline so that building elements can be properly co-ordinated. Fixed elements will include the structural frame and floors, vertical circulation and fire compartment walls.

Not all the other building and fitting-out elements will need to be equally adaptable. For example furniture will change more frequently than partitions, some partitions less frequently than others, and services connections more often than main and secondary pipe runs. This 'hierarchy' will then determine the appropriate performance specification for each element.

Servicing Strategy

Services which will be required continuously by a wide range of potential users should be distributed from a centralised source. These will include power, water, natural gas and drainage. Other demands may be more economically met by localised sources. Examples are: independent units such as compressors or vacuum pumps, or special bottled gases.

Routes for the main and secondary services distribution should be co-ordinated with the structural framework and circulation pattern of the building. The aim should not be to provide all services everywhere, but to allow for present services to be extended or new ones added easily. There should therefore be sufficient duct space and good access to the ducts. If it is designed as a 'ring main', the system will have the flexibility to meet a temporarily higher-than-average demand in any one part of the building. Locating the ring main within the spaces it serves will ensure that maintenance and alteration work does not disturb academic work taking place on the floors above or below.

Fitting Out

The adaptable elements need to be dimensionally integrated with, and physically independent of, each other. The more frequent the likely change, the more interdependence is required. Thus:

- partitions should not have services or other items fixed to them or run within them;
- furniture should be free-standing, although items can be locked to each other for stability;
- services connections to furniture should not inhibit its mobility.

This approach, when followed comprehensively, provides a building that is highly adaptable throughout. This will be appropriate where a substantial proportion of high-level scientific work is carried out and where there could be a need to change office space to laboratories, or teaching laboratories to research areas. It is also appropriate where rentals are very high and sub-divisions of the floors frequently

need to be altered to meet the precise requirements of changing tenants (e.g. office buildings).

Less Comprehensive Adaptability

However in schools and colleges where the density of servicing will be lower than for a science research building and where space does not have to be so precisely tailored as it does when rents are high, then a design that is less fully adaptable may still give satisfactory value for money. The resulting approach will have to reflect the balance of such factors as:

- the likely relationship of specialised space to unserviced or lightly serviced space;
- the affordable cost per square metre.

It may be that with careful zoning of the more highly serviced areas, it will be possible for them to be more fully adaptable while elsewhere a range of less easily adapted but nevertheless carefully selected room sizes can be disposed. These could be grouped to allow the flexibility of pairs of spaces being used together when necessary.

In any case the following design principles should be followed:

- **have small planning modules;**
- **use a structural frame rather than load-bearing walls;**
- **partition walls, whether demountable or not, should be non load-bearing and kept free of services and other fixtures;**
- **clear, direct routes for main services supply should be provided so that changes or additions can be made with least disruption to the use of the building;**
- **floor levels should be as continuous as possible;**
- **windows should be dimensioned and positioned to allow rooms to be enlarged or reduced in size;**
- **furniture and fittings should be free-standing (and so easily movable), not built-in.**

In Finland many schools and colleges were built in the 1960s with concrete structural walls, including cross walls between rooms. This has made later alterations very difficult and expensive to carry out. The general aim of the National Board of General Education is therefore now to have schools designed so that:

a.they will be suitable from the start for some other uses;

b.they are as generalised as possible; although this may mean 'special' rooms being taken up by 'normal' work when they would otherwise be empty;

c.some physical changes can be made without having what is seen as being an expensive high degree of adaptability.

Brick is preferred for the internal non load-bearing walls as it provides good sound insulation between rooms and has a good appearance. Removable partitions are only used where it is essential for rooms to be opened up or sub-divided frequently.

In France also many older schools are less flexible than would now be accepted. This is because at the time of great and quick expansion there was mass production of system building, mainly using panel construction. An open zone (of some 200 square metres) that could be re-modelled was often provided to give some adaptability. This though was more a self-imposed technical restraint rather than stemming from meeting a user need. Nowadays the approach and attitude are different. Following decentralisation, design criteria are more influenced by local requirements, as well as technical guidance from the centre. Thus the need for flexibility and adaptability have become higher priorities than before.

The Lycée Polyvalent du Cols Bouchet, Niort, is an urban renewal project in which the buildings are spread along the available site. The approach to the design of the buildings is very similar to that followed in Finland (although in appearance they have very much their own character). In the science block for example laboratories are ranged either side of a central corridor. The spacing of the windows in relation to the structural grid will allow considerable realignment of partition walls (Figure 5).

The Lycée Pilote Innovant, near Poitiers, has also been designed to be adaptable, but within the constraints of a dominant architectural statement (Figure 6). Solid structural elements are limited to the precast concrete elliptical wall surrounding the central courtyard and two triangular units which house vertical services and enclose other open spaces. Elsewhere there is a structural frame, external curtain walling, and fully demountable partitions. The main horizontal services network follows the lines of the internal circulation. Secondary runs are kept off the partitions but floor-mounted bollards in the science area cannot be moved. Thus in practice the adaptability is only between rooms and in some cases within them. It would be more difficult for departments to expand or contract.

Figure 5: Lycée du Cols Bouchet, Niort

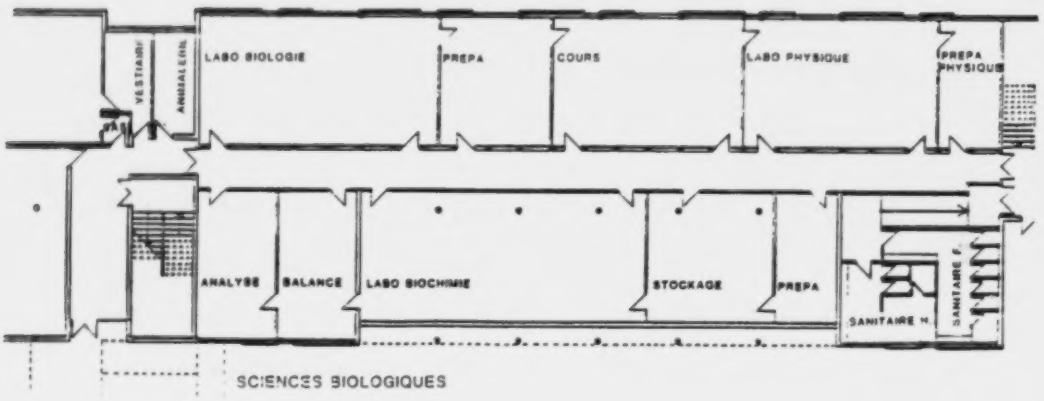
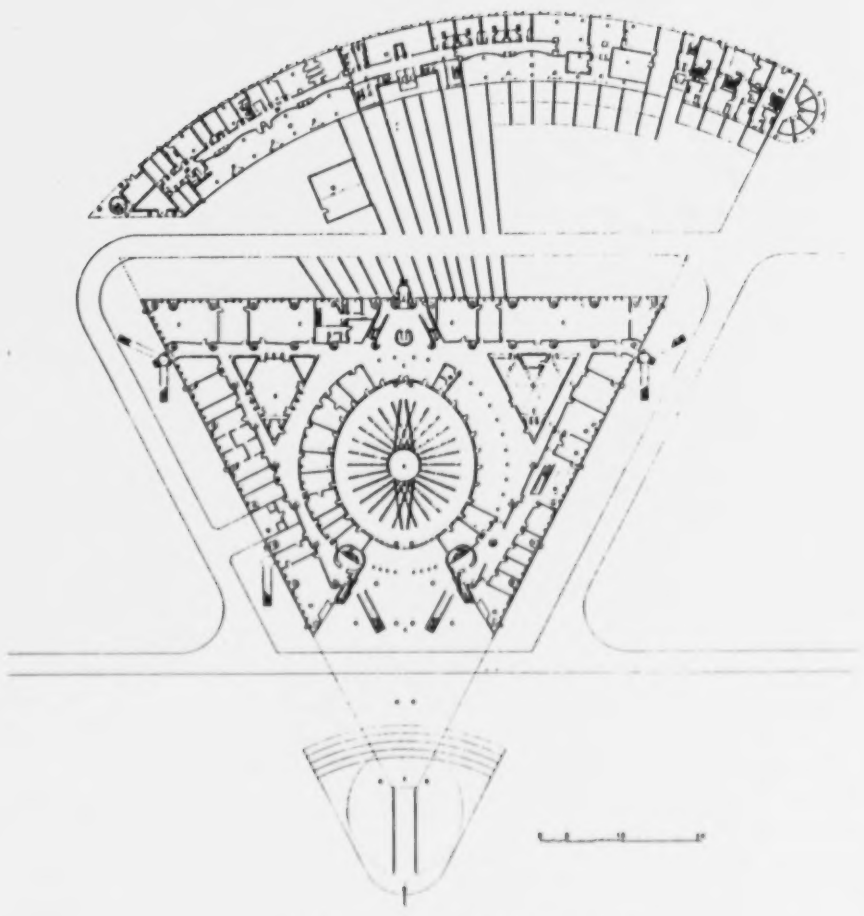


Figure 6: Lycée Pilote Innovant, Jaunay-Clan

Élévation Est.
// East elevation.



Plan du rez-de-chaussée. // Ground floor plan.

6. IMPROVING EXISTING BUILDINGS

The degree of improvement possible in any one case will depend upon such factors as:

- the structure and configuration of the building
- the money and time available for the improvement work
- the extent to which parts of the building can be freed for the improvement work to be carried out
- the attitude of those using the building.

The easiest and most cost-effective arrangement is of course for all the required work to be done as a single project. This however is often not possible, either because a whole building or a major part of it cannot be vacated for the duration of the project, or because sufficient funding is not available for the scale of project involved.

More common is for small modifications to be made from time to time as money becomes available. Too often these simply alleviate some immediate difficulty or improve a particular aspect of the building, without regard to whether such action will improve or inhibit the flexibility or adaptability of the building as a whole. Exchanging one fixed installation for another makes little organisational or economic sense when demands are changing.

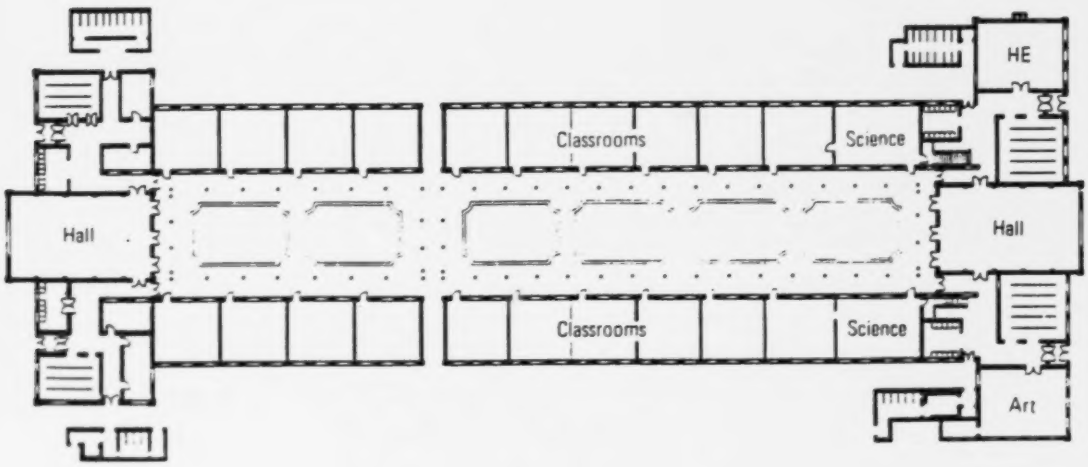
What is required therefore is a longer-term design strategy to which each later minor works project will contribute. Such a strategy would establish priorities for improvement including:

- **rationalising the zoning of activities and disposition of spaces. This can increase flexibility and offer more opportunities for the sharing of facilities. It may also be used for environmental reasons, such as the separation of quiet and noisy activities.**
- **setting down main design criteria, such as what key planning dimensions are to be adhered to and how services are to be dealt with.**
- **setting out in broad terms the types of components, fittings and finishes to be used.**

The 'tactical' design approach for the individual projects should then bedirected at remedying the shortcomings of particular spaces in relation to the strategic plan. The broad strategy itself should be flexible in concept. It should not be seen as a fixed 'master plan' that must be carried through in detail come what may. Rather it should lay down main guidelines, but be capable of adjustment if circumstances and requirements change appreciably in the future. However such adjustments should be made only after careful consideration of the consequences.

The remodelling of Ludford Street School as part of the Victoria Centre, Crewe, is an example of improving the flexibility of a rigidly designed building (Figure 7). Outside walls, structural internal walls (in the end two-storey block) and main staircases were regarded as fixed since they would have been unduly expensive to remove or alter. The new services, including a new heating system, were mostly installed in the roof space so that the floors and walls were kept as clear as possible. This allowed the two single-storey wings of standard-sized classrooms to be opened up to form 'clusters' or suites of various sized and interlinked rooms. The furniture and fittings within them are free standing; storage is mostly of mobile units.

Figure 7 a: Ludford Street - before remodelling



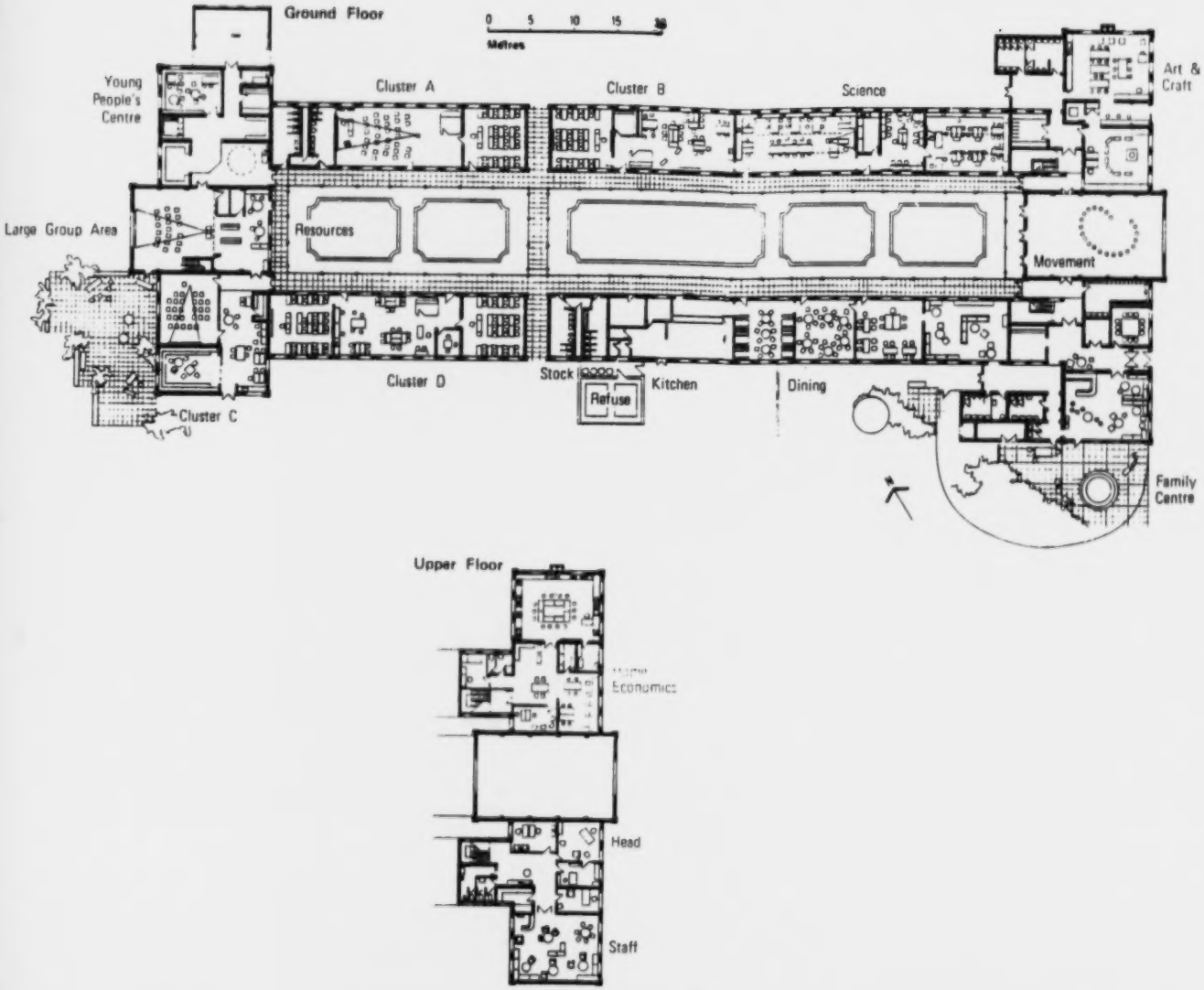


Figure 7 b: Ludford Street - remodelled plans

Free-standing Facilities

Another approach is to leave the existing structure of the building as untouched as possible and to provide some form of independent light structure within it. To this can be fixed service runs and a range of 'clip on' fittings.

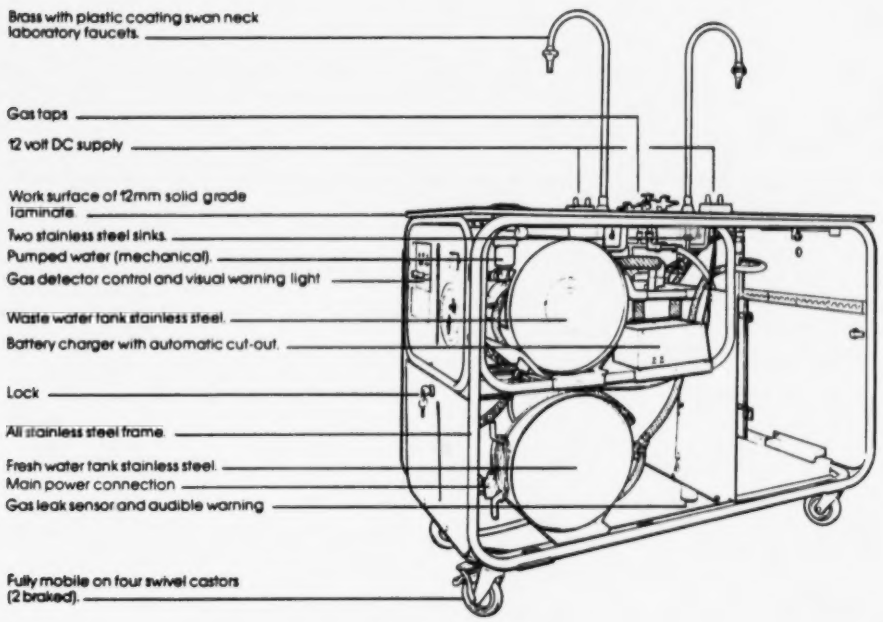
The 'Labkit Workstation System' developed in the United Kingdom is a further development of this approach (Figure 8). It provides free-standing laboratory facilities that can be to some extent be rearranged in a given space and can also be easily moved elsewhere. Prefabricated components are assembled within a space to create a series of fully serviced workstations against which moveable benches are placed. Sections of overhead trunking are bolted together, linking all workstations back to a control unit which is the only part of the system that connects to the fixed services supplies and drainage of the building. The main use of the system is for general science facilities and as such it has been installed at a number of secondary school. It has also been adapted for electronics work for the City Polytechnic, Hong Kong, where it was initially installed in a rented office block while new buildings were being constructed.

Figure 8: The 'Labkit Workstation System'

Mobile Facilities

For temporary provision of basic science facilities, a trolley system can be used. One such, developed in the United Kingdom, contains bottled gas, water and waste tanks, and a rechargeable battery (Figure 9). With tables standing on either side, a trolley can service four pupil work places. Other mobile work places are available, including for technology and computer work.

Figure 9: A mobile trolley system


Brass with plastic coating swan neck laboratory faucets.
Gas taps
12 volt DC supply
Work surface of 12mm solid grade laminate.
Two stainless steel sinks.
Pumped water (mechanical).
Gas detector control and visual warning light
Waste water tank stainless steel.
Battery charger with automatic cut-out.
Lock
All stainless steel frame.
Fresh water tank stainless steel.
Main power connection
Gas leak sensor and audible warning
Fully mobile on four swivel castors (2 braked).

Mobility has been employed in an interesting way by some local authorities in England. In Bedfordshire the desire to offer technology to all secondary school pupils led to the idea of making scarce material and staff resources widely available through the use of specifically converted buses. These are equipped with compressed air, a hydraulics kit, water and protected electrics and fixed workbenches. Additionally six resource trailers act as a back-up. Suffolk, which faces the problem of a large number of comparatively small schools in scattered rural locations, has equipped trailers with resources for teaching CDT, technology and microelectronics.

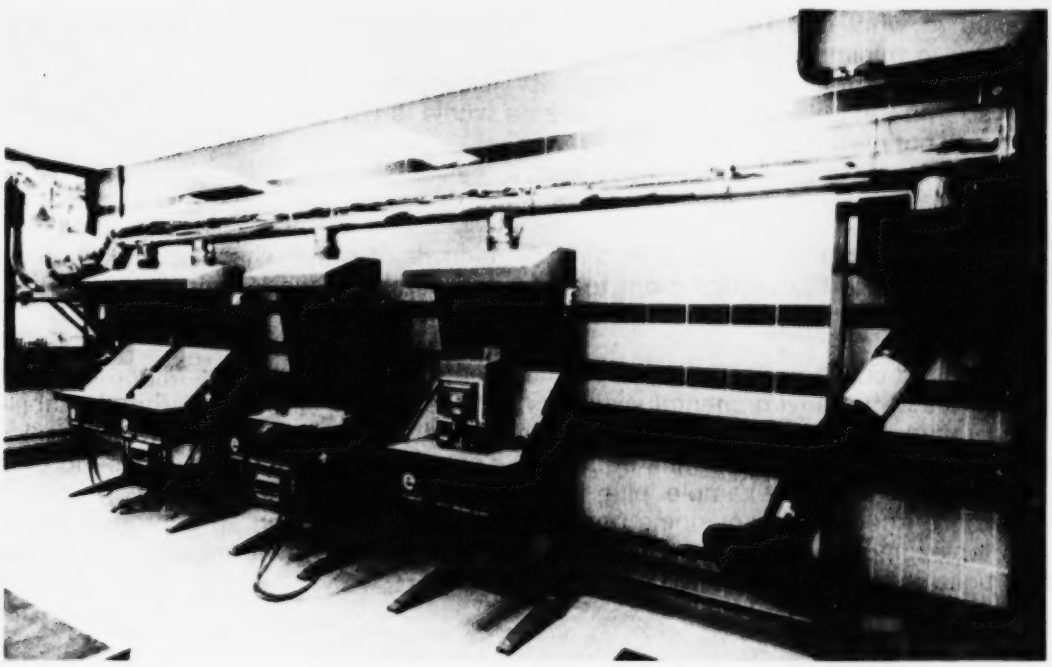
Single Project Improvement

Any project represents a balance between time, cost and quality and a close working relationship between the briefing, design and contracting team is required.

The City Technology College, Solihull, England is an example of a major improvement carried out as a single project. A four-storey former boys' school had to be converted into the first of this new type of college (for over 500 students) in only 26 weeks. The main contractor's programme highlighted when critical decisions had to be taken to enable phased floor-by-floor hand-over to those doing the fitting-out.

Alterations to the structure and heavy servicing of floor areas were kept to a minimum, and as much use as possible was made of specialist fittings and equipment that were self-contained in terms of their servicing (Figure 10). This enabled separate contracts to be let for the construction work and the fitting out of the building. Existing mechanical and electrical services were completely stripped out. The new installation was increased to accommodate the extra requirements of electrical technology, providing a complete network for computer installations. Services were brought to a single point in each room from where they were connected to the integral servicing of the free-standing equipment. This allows layouts within rooms to be changed easily and also for the basic use of rooms to be changed.

Figure 10: Solihull City Technology College



7. ENVIRONMENTAL ASPECTS

The general requirements for heating, lighting, ventilation and other environmental aspects will apply to a building regardless of adaptability and flexibility. But when designing for these qualities three main points should be to the fore. They concern zoning; the degree of control; and adaptability of the system.

Zoning

Any zoning in the planning of the building to allow partial use of the accommodation out of normal hours should at least be matched by similar zoning of the heating, ventilation and lighting systems. In this way unnecessarily wasted expenditure on fuel can be avoided. The control system should itself be flexible so that alterations to timings can easily be made. Sub-metering of areas that are likely to be used by outsiders should be considered. Administrative procedures should ensure that there is good liaison between those dealing with lettings of accommodation and whoever is responsible for controlling the environmental systems.

The size of zones will naturally be affected (as so much else in design) by a balance of what is desired and what can be afforded. However in areas where a high degree of adaptability is likely to lead to the shapes and disposition of spaces being appreciably changed, it would be wise to aim for finer tuning of the environmental services systems here too. This can help to avoid later mismatches between zones and the types of space in them.

Controls

Flexible space may itself lead to considerable changes in the environmental conditions in particular rooms, for example where heat producing equipment is installed in what had been a general classroom. It would therefore be a false economy to minimise the degree of control of heating that can be exercised by the building's occupants in individual spaces. However this should be within agreed limits so that the balance of the system as a whole is not upset or minimum statutory standards not met.

Adaptability of environmental systems

Some aspects of this have already been dealt with. There should be some spare capacity at the central plant to allow for increased loads being repaired at a later date.

Good collaboration between all members of the design team will be essential to ensure that the environmental systems match, so far as is possible, theadaptability aimed for in the other aspects of the accommodation as a whole. New technical solutions may need to be sought, or solutions adopted that are already in use in other types of building. For example 'plug in' ventilation or mechanical extraction units, to allow more freedom in replanning particularly workshops. Such an approach can be seen for example for dealing with moveable booths in airport terminals or individual shop units in multiple shopping centres.

8. INFORMATION TECHNOLOGY (IT)

With the growth of IT throughout schools and colleges, cable distribution becomes a main technical consideration. Cable distribution can be thought of in terms of three levels (Figure 11):

- primary: main supply and distribution about the building;
- secondary: distribution about a work space or group of work spaces;
- tertiary: distribution at the work place.

When designing a new building the primary routing will be dealt with in the same way as for the rest of the building's main supply services. The secondary distribution will also, though with additional options open.

Difficulties may arise however when introducing cabling within an existing building. Here the issues to be faced include:

- the capacity of the existing electrical distribution
- data cable distribution and networking
- the number and disposition of outlets required
- how to deal with exposed cabling
- restrictions on layout that service distribution imposes.

The criteria for secondary distribution include:

- will the system be able to cope with a large number of cables?
- can it provide outlets to a wide range of locations, including high density at special locations?
- can locations of socket outlets be easily altered?
- is the system prone to damage?
- is it easy to maintain?
- can it provide services to positions in the centre of the room?

The principal options for secondary distribution are (Figure 12):

- raised floors
- floor trunking
- suspended ceiling void
- suspended boom
- perimeter trunking.

Figure 11: Primary, secondary and tertiary cable distribution

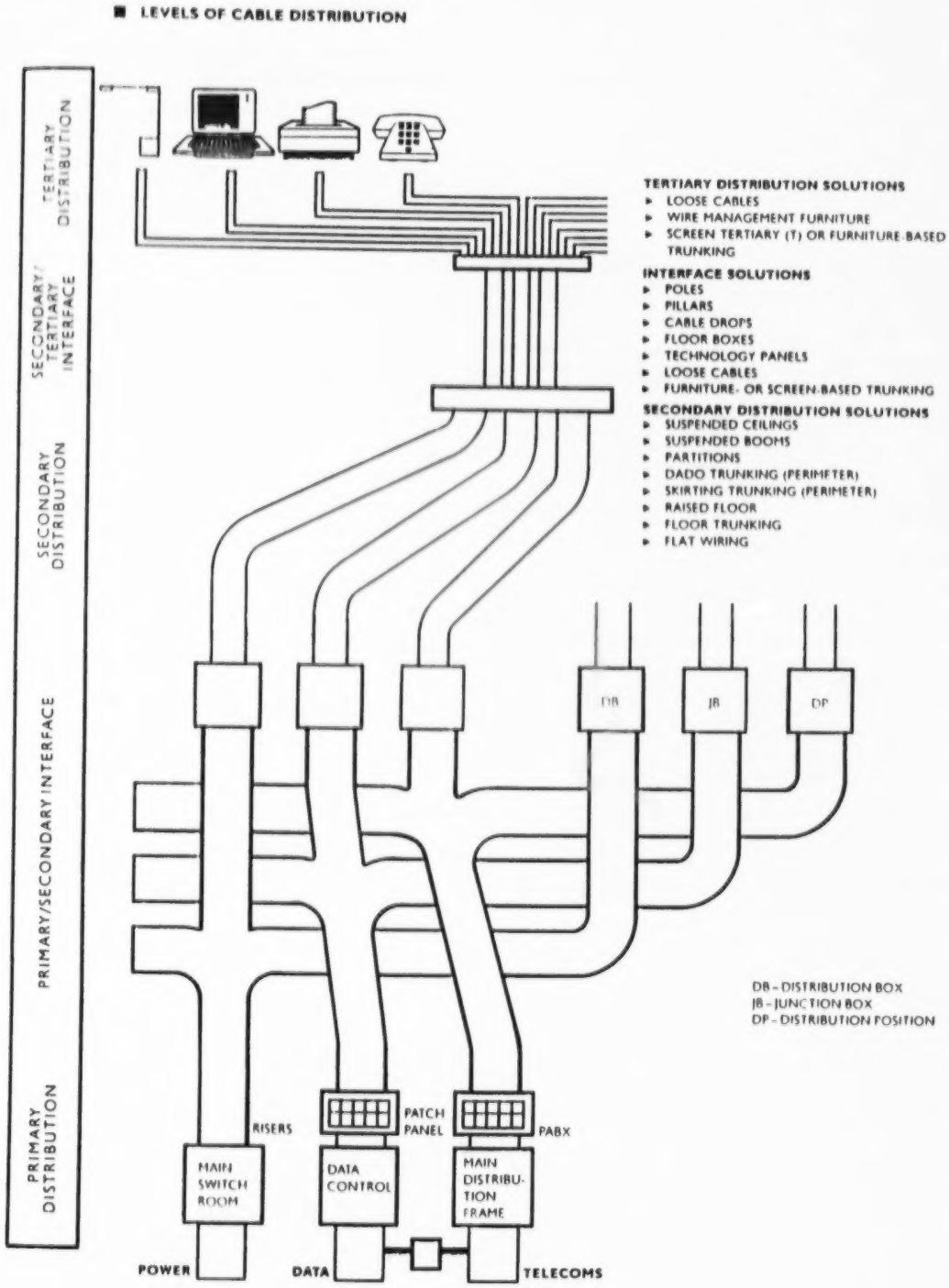
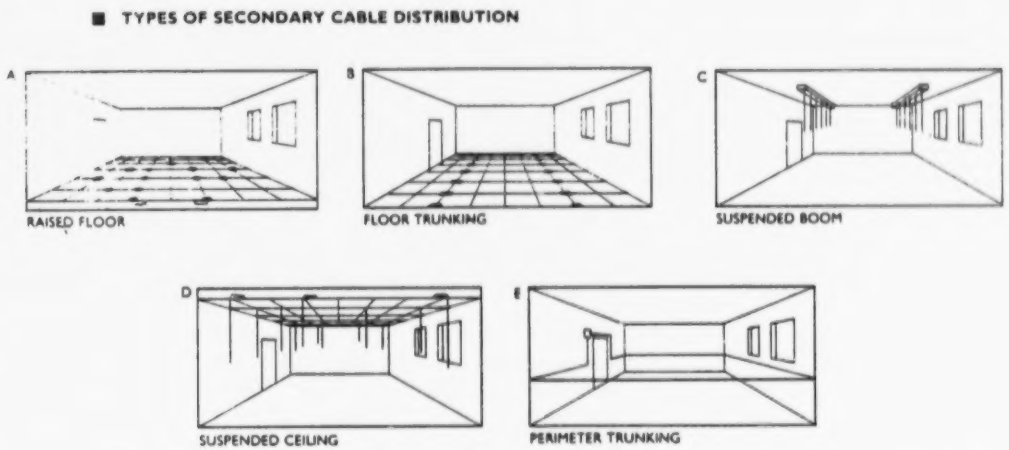


Figure 12: Types of secondary cable distribution



The need for tertiary distribution has been recognised in terms of the proliferation of cables at the work place (cable management); and the advantages of cabling between work stations (avoiding expensive floor or ceiling connections at each work station).

The options here are more limited:

- loose cables (the general situation at the present)
- integrated furniture distribution: cables are run through the structure of the furniture
- furniture-mounted trunking: cable ways are added to existing furniture
- screen or wall-mounted trunking: cables are carried in trunking on the walls and screens that the furniture abuts.

In general the last two options are preferred on grounds of cable management, flexibility and cost.

The Commercial College, Vantaa, Finland is a recently designed building in which flexibility, adaptability and the incorporation of IT are important factors. Information can be sent via a closed-circuit TV system throughout the building. Within the classrooms, data and power cabling is dropped from ceiling-mounted booms (spaced at 1.2m) to junction boxes serving groups of equipment.

Furniture is co-ordinated to some extent allowing easy rearrangement. Overhead lights can be moved in both directions to suit changed furniture layouts. Wall trunking is also provided in office spaces. Demountable cooling units are fitted at high level on the corridor side of rooms housing equipment that produces considerable heat.

Demonstration rooms, adjacent to the office techniques and other technical classrooms, can act as overflow classrooms if necessary. They allow flexibility in rearranging equipment and for group work. At present new equipment is tested and demonstrated there. Electronic mail, telefax and a main terminal are placed there too. Also between rooms are separate areas where students can practice working at computers on their own. Most walls between rooms and circulation space are glazed so that it is easy to see when equipment (or private study space) is free. The servicing arrangement is unobtrusive and effective. This, together with the grouping of rooms and access between them, has enabled rooms to switch their use and equipment, and furniture layouts to be changed, straightforwardly by the college staff themselves. With a move towards small groups, free-standing screens would be used for sub-division.

The Alford IT Centre, Aberdeenshire, Scotland, is seen as combining the three inter-dependent elements of building, equipment and staff. It comprises a group of ten different-sized spaces equipped with a wide range of information handling material. While the shapes of rooms are fixed, reasonable flexibility is inherent in the Centre as a whole from the variety of room sizes and the use of two sizes of table, both relatively small, in a variety of groupings. The large classroom has been provided with two full length overhead power booms as well as perimeter trunking. This has enabled it to be used by two or three independent groups simultaneously and to service classes which are all making use of individual electronic keyboard and screen equipment. Several complete changes of room layouts have already been made since the Centre opened in October 1986. It is available, through a joint Management group, to classes in the school and to the wide-spread rural community among whom it is situated[1] .

9. HEALTH AND SAFETY

These matters are the concern not just of the designer of a building or its management but of everyone, including the users. Health and safety is a field where requirements and the information available are constantly being updated whether from new legislation, new technical knowledge or perceived good practice. Requirements may vary from country to country and for some aspects locally within a country.

It is also a specialised field and so each school or college should have its own safety officer. This role is likely to be combined with other duties except in a large institution (where there may also be a safety committee). The safety officer should ensure that those using the building - and particularly its specialised facilities - are made familiar with the institution's safety policy and with current advice and regulations on all safety matters. This will apply equally to students and staff. In©service training for key staff, the issuing of newsletters, visual display material and the like all play their part. Technical staff should be particularly aware of their day to day responsibilities and should receive adequate training.

Some schools or colleges occupy buildings that were designed before some currently perceived dangers became apparent. In any case most buildings have a long life. It is therefore the responsibility of Management to aim constantly to improve safety within them. This will involve both physical improvements: for example providing adequate means of escape for the physically handicapped or extending alarm systems; and improvements in procedures: for example dealing with accidents in laboratories and workshops, and evacuation in the case of fire.

- **When the design for a new project is initiated, and again at the fitting- out stage, the safety officer (and the local authority's inspector or adviser) should be brought into discussions with the architect to comment on points relating to health and safety requirements, particularly for specialised facilities. The local Fire Authority should also comment on early sketch designs as well as the final scheme.**

The sooner the architect is made aware of all detailed requirements (some of which may be laid down by the institution itself), the better can they be incorporated into the design in a way that will be effective, will not reduce intended flexibility and adaptability, and will be visually acceptable.

Some potential hazards will be obvious, such as unsuitable flooring and glazing, dangerous obstructions and poorly planned circulation. Others will be less immediately apparent, such as materials and substances that could causeallergic reactions in hypersensitive people. Safety of working conditions can also be impaired by unsuitable heating, ventilation and lighting.

Careful attention should be given to the storage of materials, tools, equipment and work in progress in terms of safety as well as practicality. There should also be adequate storage for outdoor clothing and bags so that working and circulation

spaces do not become cluttered. Requirements for the storage and use of volatile liquids, gas bottles and the like are stringent. The location, design and construction of special stores for them must be approved by the appropriate authorities. Secure free-standing cupboards are increasingly available which would not inhibit the freedom to re-arrange spaces as would built-in stores.

Where the project relates to an existing building it is important for the architect to be, or to become, sufficiently familiar with the building, and the way in which it is used, so that changes to it do not expose the occupants to unforeseen risks. (The advantages of continuity of expertise are discussed in Section 10.)

Improving the adaptability of an existing building may involve considerable upgrading of its services provision, some of which may be related to safety items - such as new fire shutters, to be linked to the central alarm system. The use of a colour code for the various supply services is an advantage from a safety point of view. Electricity supplies of different voltages and phases should also be clearly distinguished. A major constraint when designing science accommodation concerns the provision of fume cupboards and their associated ductwork: both in terms of qualities and locations. Changes in either are costly to make and the installation may therefore become an obstacle that hinders future adaptations generally. Because of this and also because of energy considerations, a mobile recirculatory fume cupboard for chemical work has been developed. It contains filters and sophisticated gas detection and other safety devices. For operation the fume cupboard needs only a low power electrical supply. With any building, old or new, a record of its specification should be kept for future reference. This would help to avoid improvement work inadvertently creating dangerous situations, as when for example asbestos is unexpectedly exposed.

A User Manual (see Section 10) should contain guidelines and procedures for ensuring that means of escape and other safety aspects are not impaired when in-built flexibility or adaptability is made use of. Diagrams and instructions should illustrate principles where possible rather than just lay down 'good' and 'bad' arrangements, as the latter way might restrict possibilities. Curriculum innovation can lead to the introduction of equipment and materials to existing teaching spaces where no provision has been made for them. The Manual should also deal with the safety aspects of this, as well as ensuring that new equipment with a heavy electrical demand do not overload the system.

Safety in respect of hazardous machines and equipment should be checked when alterations have been made. There should also be regular liaison with thelocal Fire and Safety Authorities to ensure that changes in usage have not in fact created potential risks.

Regular testing of fire precautions under simulated conditions should take place, at least at the beginning of each academic year when there will be a new generation of pupils or students and perhaps some new staff.

10. MANAGEMENT

In many countries increasing decentralisation of educational administration means that more responsibility is now being taken at school and college level for financial and administrative matters. This greater freedom should provide financial incentives for maximising the efficient use of buildings and the expensive facilities in them.

Improving the use of existing accommodation

There are by now many examples of colleges systematically analysing the way in which their accommodation is used day by day through the term and then improving this use, sometimes considerably, through better space Management. The Architects and Building Branch of the Department of Education and Science of the United Kingdom has published guidance on ways of doing this and has also published the results of some detailed surveys carried out by colleges in England[2].

Undertaking such a survey is the first step towards seeing how best the use of space can be improved. It may be that by time-tabling rooms centrally instead of having each department solely responsible for its own accommodation will in itself make the desired improvement. However comparison of the range of spaces available with the frequency with which teaching groups of various sizes need to be accommodated will show whether some changes in room sizes would be beneficial. The likely cost of the alteration work involved can then be set alongside the anticipated benefits from the higher density of use over time.

Networking

Another way of obtaining greater intensity of use of existing specialised facilities, rather than providing new ones, is through networking between institutions and by the shared use of school and college facilities by 'outsiders'. The remark by a university Vice-Chancellor that it would be cheaper for him to send his students by Rolls Royce to another university to use specialist equipment that already existed there, than for him to have it installed at his own campus, could be applied in many other circumstances. Many examples exist of such sharing. A few are described below.

- chemistry laboratories at the Lycée Professionnel de Rochefort, France shared between students of the Lycée and local industrial firms; it is of interest that such sharing has led to joint commercial projects being carried out by the Lycée and industry;

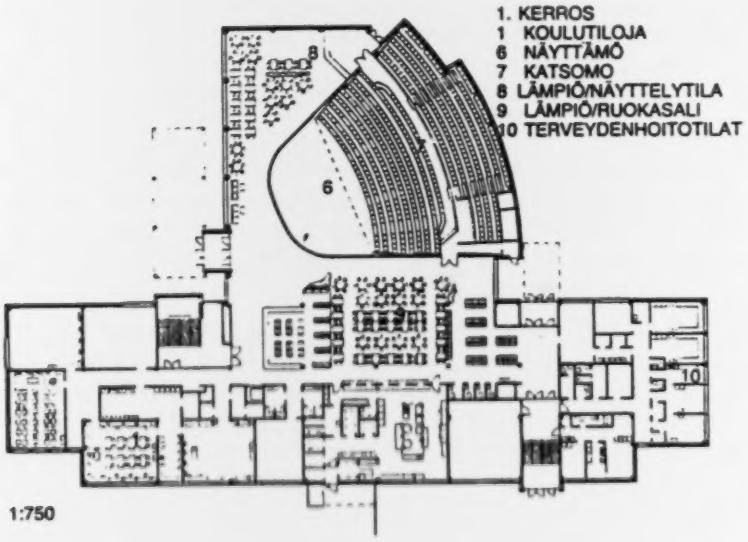
- the Lycée Pilote Innovant (see Section 5) where a high school and advanced college/university occupy a single complex building in which it is intended that many of the facilities (and particularly the specialised ones) will beshared by the two institutions. Data technology and media techniques will be main areas of focus;

- in Finland a number of small institutions were seen to be sharing language laboratory facilities as there was not sufficient demand at any one of them to allow a high level of use.

- at Tapiola in Finland the building housing both an upper secondary and upper comprehensive school is a multi-purpose resource available to the two schools and to the public. Each school has its own headteacher but some teachers are common to both and some spaces are shared: these include science laboratories, the library, social areas and the auditorium. On the other hand as both schools are relatively large, much of the teaching accommodation is kept under the control of one or the other. The building is used for evening classes, and the public can hire certain areas for meetings, receptions and the like. There is a kindergarten for children of students of the large evening school (some adult classes are also fitted in during the day).

- the Laurentius Hall and Anttila School, Lohja, Finland (Figure 13) was designed to give joint school/community provision as part of a larger flexible complex. Anttila is a lower secondary comprehensive which, together with the adjacent senior secondary school and ancient church of St Lauri, provide a range of academic and cultural facilities in the centre of the town of some 14,000 inhabitants. During the day the building serves as a school for over 500 pupils who also use some of the classrooms in the adjacent buildings. The school's Health Care Centre serves the pupils of neighbouring schools as well. The local Workers' Educational Institute and a College of Music occupy the ground floor in the day. After school hours the building, and in particular the 550-seat hall, is used for leisure and cultural programmes, for example concerts and meetings of the City Council.

Figure 13: Laurentius Hall, Lohja



- a new secondary education complex at Golden Grove in South Australia incorporates a core of shared specialist facilities[3].

Such sharing will raise a number of practical questions that must be resolved if the arrangement is to work to the satisfaction of the various organisations involved.

Shared responsibility and costs can best be dealt with by a joint Management group. It must be decided whether the host institution will have first priority of use or whether sharing is to be on an equal basis.

Is more Accommodation really needed?

If an institution has to accommodate more pupils or students, its immediate response might be to assume that more accommodation is needed. This is not necessarily the case. It may be that demand could be met, in full or in part, by a change in approach to the use of facilities, again leading to their higher utilisation.

Such a survey was carried out for Wye College, Kent, England, following a utilisation survey as described above. At this college the students have a choice not only between combinations of courses but also of options within them, making timetabling complex and more than normally difficult when done manually and resulted in teaching laboratories being under-utilised. The study showed that by modifying the existing laboratories and in particular by providing two multi-discipline ones, each capable of housing any practical scientific subject except geology, utilisation could be improved to the extent that the College would not only not need new accommodation but could also release some of its laboratories for other purposes. A computerised system for timetabling and space allocation was also adopted by the College.

Improvement Projects

If, after considering these possibilities, it is decided that an improvement project should be carried out then a vital question to be raised is whether the institution will be able to make such physical changes to its buildings without having to get prior approval from its local authority. Examples were seen where they could not, and that restriction was enough to inhibit the work being carried through. In some countries, while the local authority will continue to deal with main structural work, institutions will increasingly be responsible for repairs, maintenance and minor capital works.

Assuming that a way is found for the work to go ahead, then it is essential for the initial design approach to be followed through at all stages of the job, includingthe fitting out and furnishing. Too many examples have been seen where the original planned potential for adaptable accommodation has been badly limited by specific requirements made at a late stage in the work. In many cases there have been requests from specialist subject advisers or Heads of Departments whose concern is understandably in terms of their own subject or subjects but without their realising the consequences on the broader intentions of the projects.

In new workshops at a college in Finland, the architect's original intention was to have free-standing meeting areas within the workshops enclosed with demountable partitions to give maximum adaptability. This had been overruled in favour of the use of block walls. These could, of course, be repositioned but not at all as easily or cheaply as with the original arrangement.

At a school in England a forge and welding unit was brought (at a specialist adviser's instigation) into what had been designed as a multi-use space. The safety restrictions relating to its operation and the necessary extract ventilation that had to be added, between them made the rest of the space virtually inoperable for the wider range of intended activities.

Conversely at a different college in Finland where a new building was to be designed, the principal took firm control from the time of the initial briefing of the architect, through to completion of the fitting out and the early use of the new accommodation. Flexibility and openness were to be the main aims of the design and they were achieved despite pressures for modifications to the plans that would have made them less so. What is of interest is that although the building has only been in use for a short time, a number of changes of use have already taken place. Moreover the majority of the staff are much more pleased with the building than they expected to be.

- **A senior manager in the institution should have responsibility for co-ordinating the requirements put to the designers. This will need to be a person who has the ability to have an overview of the aims of any project and with authority over individual specialists, whose demands he or she can judge in the context of what is best for the school or college as a whole.**

Professional Advice

Equally important if improvement work is to be as effective as possible, is for the institution to have available suitable professional advice, either on a consultancy basis or, for a larger institution, permanently on its own staff. In either case continuity of expertise is important so that a two-way understanding is built up between the people in the institution most closely concerned with the physical changes and those planning for them and overseeing their implementation. This continuity is most important to have so that the designers get to know more about the way the school or college works and what its main concerns are and that the teaching and administrative staff begin to learn what is possible and what are the consequences of the requests they make of the designers. Imaginative designerswill be able to suggest different solutions to problems and can often turn seeming difficulties to advantage.

Project Management

Whether a project is for a small improvement within the context of gradually increasing the adaptability and flexibility of the building (see Section 6), or whether it is a major addition or extension, a number of project management questions will arise.

- *Choice of consultant*

It is essential to choose consultants who are fully committed to the approach to meet short- and longer-term changes of requirement. There is advantage in bringing the architect in at the briefing stage and thus making it a two-way process. An architect with previous experience of designing for flexibility or adaptability with other than educational buildings can well make significant suggestions at this early stage. Briefing and concept designing should be able to influence each other rather than being thought of as being two self contained processes.

- *at Briefing stage*

What degree of adaptability and flexibility is required in the building overall? What balance between adaptability and flexibility is appropriate for the various parts of the accommodation?

Both these questions will be affected by an assessment of the new accommodation in life cost terms: what would be an appropriate balance of capital and running costs, including staff costs. Moreover one must ensure that highly specific needs are not allowed to inhibit the intended ability of the building to respond to change. Finally the timescale of the project must be clearly understood by the key staff of the institution and by specialist advisers who will be making input to the briefing process. Dates for 'no further change' should mean what they say.

- *at Design stage*

There should be regular liaison between the institution's coordinator, with his colleagues, and the designers. This is to ensure that the requirements of the brief are being met and that flexibility or adaptability are not being inadvertantly eroded through other design features taking precedent. Presentations made to key staff of the institution should give to them a clearer understanding of how the inherent flexibility and adaptability can be made use of in the future.

- *at Fitting-Out stage*

The selection of furniture and equipment should be an integral part of the design process. Too often these items are taken out of the responsibility of the architect and the institution and are dealt with by a separate department of a local authority. In that case price rather than the appropriateness of the chosen items may become the main criterion. Furniture and equipment should be compatible one to another so that rearrangements within and between spaces do not lead to mismatching.

As with the building as a whole, a balance should be struck between the initial cost of furniture and fittings, their required life and the likely cost of replacement. The same level of specification will not necessarily be

appropriate throughout. For example it is a false economy to economise on items such as taps, valves and other moving parts that will be heavily used.

Facilities Management

Ensuring that best use is made of what are becoming increasingly sophisticated specialised facilities involves more than just time-tabling the rooms as has generally been done in the past. All aspects of the use of space and facilities, the re-allocation of spaces, the maintenance of the facilities and their general upkeep should be under the control of someone of authority. For a sizeable institution this could well be a full time post and as such is often known as a 'Facilities Manager'. It is his (or her) role to aim at achieving optimum utilisation of the accommodation overall as described above.

To this end decisions must be made on how much space is allocated centrally and to what extent, if any, departments will hold some accommodation primarily for their own use. There is no doubt that the highest utilisation will be achieved if all is dealt with from the centre. For this to work smoothly, however, human factors must be taken into account. It is noteworthy that the computer-based system referred to earlier makes allowances for a range of preferencesexpressed by the teaching staff who will use the spaces. However, experience also shows that in a large institution students and staff tend to take more care of spaces that they consider to 'belong' to their own department. A compromise arrangement might therefore be for some spaces to be allocated to departments to be responsible for, provided they are utilised up to an agreed level and for all other accommodation to be allocated centrally.

A 'user manual' should be prepared. In it would be set out clearly both how flexibility and adaptability had been allowed for and also the procedures to be adopted within the institution when someone wants to have changes made. These procedures should be as straightforward as possible so as not to deter people but should also ensure that changes do not lead to new layouts that could be hazardous.

Besides having this handbook available or distributed, seminars could be held from time to time to keep the users of the building well informed about the potential of the building and its facilities. Such seminars could be run jointly by the facilities manager and the architect for the building.

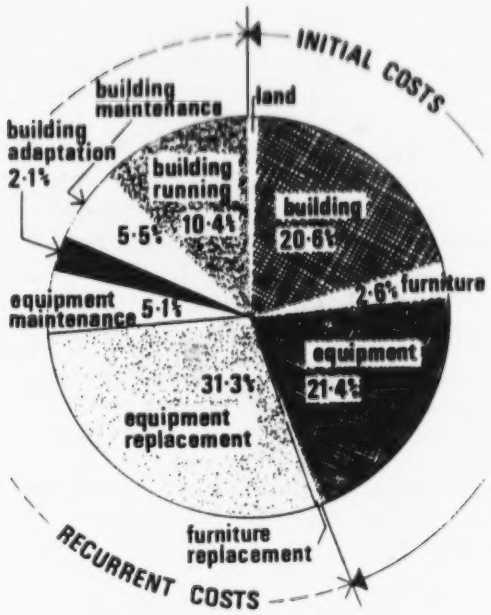
- **Given a positive attitude, the occupants can be the most flexible element in the working life of a building. Conversely, if they have a rigid outlook then advantage is unlikely to be taken of the most flexible or adaptable building. It is the responsibility of the managers of the institution to stimulate and encourage a positive approach.**

11. ECONOMIC CONSIDERATIONS

Life Costs

In the past budgetary control has tended to concentrate on initial capital cost, usually unrelated to the cost of furniture and fittings, and paying little or no regard to continuing costs. These continuing costs, or 'life costs', can be represented on an annual basis. Figure 14 shows (for a university science building) that the cost of equipment and its replacement represent just over half of the total cost of land, constructing the building and its running and maintenance. When staff salaries are taken into account, capital costs shrink to some 14% of the total while the relationship between building and equipment costs remain the same.

Figure 14: Total life costs



49

For a school or college the figures will of course be different but the proportion represented by staff salaries will still be high. This illustrates the importance of designing accommodation that will be responsive to changing needs and so will not hinder staff from working efficiently and will enable the equipment to be utilised effectively. The increasing adoption of cost centre accounting makes such considerations particularly relevant.

Investment appraisal techniques can be used for determining an appropriate cost target for a project. This involves, at the budget setting level, the costing of options to meet the project objectives and at the project level, an assessment of benefit to be gained from particular design details on constructional methods. Investment appraisal is a means of counter-balancing present capital investment with future benefits to be gained from that investment by means of discounting procedures. A cautious view should be taken of possible future benefits[4].

Cost Planning

A cost plan for a new building or alteration project should be drawn up before any design work is begun. It should be based on previous experience, statistical data from cost analyses of similar projects, and take account of any elements that might be particular to that project. The plan will set a cost target not just for the project as a whole but for each main and subsidiary element within it. As design work develops the resulting anticipated cost of each element can be periodically checked against its cost target. Detailed design or specification can be adjusted if necessary. Alternatively savings can be made on one element to cover increases on another. In this way cost control can be maintained through the life of the project.

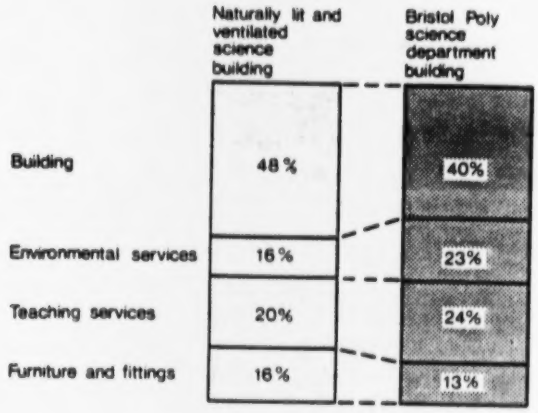
- **It is strongly recommended that for cost planning purposes, the total money available for building work and furniture is treated as one, regardless as to whether it is allocated from different sources. The flexibility thus obtained has been found to be of great advantage in getting the best end results, provided only that user requirements are satisfied.**

Flexibility and adaptability can be provided in a new building without incurring higher initial cost than would have been the case with a fixed design. This was so with the Charles Darwin Building (Figure 15). Here more was spent on providing comprehensive environmental and teaching services, including drainage, and a high proportion of demountable partitioning. But compensating savings were made by having an economical floor-to-external wall ratio and reduced total floor area, by taking account of the potential for compact planning and good utilisation levels and by allowing savings occurring from the design of the loose laboratory furniture to go towards paying for the enhanced teaching services provision.

Additional Funding

The addition of community (or other) money to a basic building project can allow extension of the range of facilities to a level beyond what either source of funding could provide on its own. This in turn, given that they are so designed, can increase the flexibility of use that is possible with such facilities. Examples of this include the Victoria Centre, Crewe and projects in Finland that combine an auditorium and shared complementary social facilities with a school or college. Although it is difficult to quantify the benefits thus obtained, they are nonetheless real and should be taken into account. For example, juvenile crime and vandalism rates may drop in areas where there is good community provision. This has been seen from several projects in New York, and the Sutton Centre and the Victoria Community Centre.

Figure 15: Charles Darwin Building - cost distribution



---

1 For a fuller report see '*Long-term perspectives 6*: The Alford information technology centre' OECD/PEB, Paris 1989

2 A & B Paper No.4: Stockton Sixth Form College - Space Utilisation Survey, Department of Education and Science, London, 1979;
A & B paper No.6: Hounslow Borough College - Space Utilisation Survey, Department of Education and Science, London, 1980.

3 *Long-term perspectives 5*: Golden Grove - a secondary education complex in South Australia, OECD/PEB, Paris 1989.

4 The application of economic appraisal to educational building, OECD/PEB, Paris 1987.

ANNEX: PAPERS PRESENTED BY PARTICIPANTS

BELGIUM	ADAPTABILITY AND FLEXIBILITY	Ministerie van Onderwijs Gebouwenfonds voor de Rijksscholen
FINLAND	THE ADAPTABILITY OF PRIMARY SCHOOLS IN HERVANTA-SUBURB, TAMPERE-FINLAND	Alpo Reinivaara Chief Education Oficer
FRANCE	QUELQUES EXEMPLES D'ADAPTABILITE ET DE FLEXIBILITE INCORPOREES A LA CONCEPTION ET A LA GESTION DES LOCAUX ET BATIMENTS SCOLAIRES	Ministère de l'Education nationale
GERMANY	VOLKSHOCHSCHULE (VHS) DER STADT BIELEFELD IN DER ALTEN RAVENSBERGER SPINNEREI	Gregor Friedl ZNWB
IRELAND	BIRR COMMUNITY SCHOOL, CO. OFFALY	Philip Doyle, Architect Dept. of Education, Dublin
NETHERLANDS	USING THE COMPUTER IN RESEARCHING FLEXIBILITY	Stichting ICS Rotterdam
NORWAY	FLEXIBILITY AND ADAPTABILITY OF SCHOOL BUILDINGS	Ole Briseid (Ministry of Church and Education) and Lars Møllerud (Norwegian Association of Local Authorities)
PORTUGAL	THE EVOLUTION OF THE EDUCATION-SYSTEM IN PORTUGAL- ADAPTATION OF SCHOOL BUILDINGS TO NEW PEDAGOGICAL DEMANDS	Ministry of Education (Department of School Facilities)
SPAIN	FLEXIBILITY AND ADAPTABILITY IN THE TEACHING-LEARNING ENVIRONMENT: THE SPANISH CONTEXT	Gabinete Tecnico Ministerio de Educacion y Ciencia, Junta de Construcciones, Instalaciones y Equipo Escolar
SWITZERLAND (Basel)	TRANSFORMATION D'ATELIERS DANS LES LOCAUX D'ENSEIGNEMENT D'INFORMATIQUE	Hochbauamt Basel-Stadt
SWITZERLAND (Vaud)	EXEMPLES D'ADAPTABILITE ET DE FLEXIBILITE EN SUISSE	A-F.Luscher, Architecte

UNITED KINGDOM (Croydon)	EXAMPLES OF HOW ADAPTABILITY AND FLEXIBILITY HAVE BEEN INCORPORATED INTO THE DESIGN AND MANAGEMENT OF EDUCATION BUILDINGS AND THE MAIN PROBLEMS ENCOUNTERED IN THE PROCESS	Terry Osborn Education Officer London Borough of Croydon
UNITED KINGDOM (Grampian Region)	PRIMARY SCHOOL DESIGN IN A RAPIDLY CHANGING DEMOGRAPHIC/EDUCATIONAL SITUATION IN GRAMPIAN REGION, SCOTLAND	Grampian Regional Council
UNITED KINGDOM (Lothian Region)	NEW LEITH ACADEMY, EDINBURGH, SCOTLAND	Lothian Regional Council Department of Architectural Services
UNITED KINGDOM (Newcastle)	A PAPER ON THE DEVELOPMENT OF PRIMARY SCHOOL BUILDINGS IN AN URBAN AREA	Mrs. Angela Gibson Research Assistant Newcastle upon Tyne MDC.
UNITED KINGDOM (Powys)	BUILTH WELLS HIGH SCHOOL	Powys County Council

Limited copies of the above papers are available free of charge from the PEB Secretariat, OECD, 2 rue André Pascal, 75775 PARIS Cedex 16, France

WHERE TO OBTAIN OECD PUBLICATIONS
OÙ OBTENIR LES PUBLICATIONS DE L'OCDE

Argentina – Argentine
Carlos Hirsch S.R.L.
Galeria Güemes, Florida 165, 4° Piso
1333 Buenos Aires
Tel. 30.7122, 331.1787 y 331.2391
Telegram: Hirsch-Baires
Telex: 21112 UAPE-AR. Ref. s/2901
Telefax:(1)331-1787

Australia – Australie
D.A. Book (Aust.) Pty. Ltd.
648 Whitehorse Road (P.O. Box 163)
Vic. 3132 Tel. (03)873.4411
Telex: AA37911 DA BOOK
Telefax: (03)873.5679

Austria – Autriche
OECD Publications and Information Centre
4 Simrockstrasse
5300 Bonn (Germany) Tel. (0228)21.60.45
Telex: 8 86300 Bonn
Telefax: (0228)26.11.04

Gerold & Co.
Graben 31
Wien I Tel. (0222)533.50.14

Belgium – Belgique
Jean De Lannoy
Avenue du Roi 202
B-1060 Bruxelles
Tel. (02)538.51.69/538.08.41
Telex: 63220 Telefax: (02)538.08.41

Canada
Renouf Publishing Company Ltd.
1294 Algoma Road
Ottawa, Ont. K1B 3W8 Tel. (613)741.4333
Telex: 053-4783 Telefax: (613)741.5439
Stores:
61 Sparks Street
Ottawa, Ont. K1P 5R1 Tel. (613)238.8985
211 Yonge Street
Toronto, Ont. M5B 1M4 Tel. (416)363.3171

Federal Publications
165 University Avenue
Toronto, ON M5H 3B9 Tel. (416)581.1552
Telefax: (416)581.1743

Les Publications Fédérales
1185 rue de l'Université
Montréal, PQ H3B 1R7 Tel.(514)954-1633

Les Éditions La Liberté Inc.
3020 Chemin Sainte-Foy
Sainte-Foy, P.Q. G1X 3V6
Tel. (418)658.3763
Telefax: (418)658.3763

Denmark – Danemark
Munksgaard Export and Subscription Service
35, Norre Sogade, P.O. Box 2148
DK-1016 Kobenhavn K
Tel. (45 33)12.85.70
Telex: 19431 MUNKS DK
Telefax: (45 33)12.93.87

Finland – Finlande
Akateeminen Kirjakauppa
Keskuskatu 1, P.O. Box 128
00100 Helsinki Tel. (358 0)12141
Telex: 125080 Telefax: (358 0)121.4441

France
OECD/OCDE
Mail Orders/Commandes par correspondance:
2 rue André-Pascal
75775 Paris Cedex 16 Tel. (1)45.24.82.00
Bookshop/Librairie:
33, rue Octave-Feuillet
75016 Paris Tel. (1)45.24.81.67
(1)45.24.81.81
Telex: 620 160 OCDE
Telefax: (33-1)45.24.85.00

Librairie de l'Université
12a, rue Nazareth
13602 Aix-en-Provence Tel. 42.26.18.08

Germany – Allemagne
OECD Publications and Information Centre
4 Simrockstrasse
5300 Bonn Tel. (0228)21.60.45
Telex: 8 86300 Bonn
Telefax: (0228)26.11.04

Greece – Grèce
Librairie Kauffmann
28 rue du Stade
105 64 Athens Tel. 322.21.60
Telex: 218187 LIKA Gr

Hong Kong
Swindon Book Co. Ltd
13-15 Lock Road
Kowloon, Hong Kong Tel. 366.80.31
Telex: 50 441 SWIN HX
Telefax: 739.49.75

Iceland – Islande
Mal Mog Menning
Laugavegi 18, Postholf 392
121 Reykjavik Tel. 15199/24240

India – Inde
Oxford Book and Stationery Co.
Scindia House
New Delhi 110001 Tel. 331.5896/5308
Telex: 31 61990 AM IN
Telefax: (11)332.3993
17 Park Street
Calcutta 700016 Tel. 240832

Indonesia – Indonésie
Pdii-Lipi
P.O. Box 269/JKSMG/88
Jakarta12790 Tel. 583467
Telex: 62 875

Ireland – Irlande
TDC Publishers – Library Suppliers
12 North Frederick Street
Dublin 1 Tel. 744835/749677
Telex: 33530 TDCP EI Telefax : 748416

Italy – Italie
Libreria Commissionaria Sansoni
Via Benedetto Fortini, 120/10
Casella Post. 552
50125 Firenze Tel. (055)645415
Telex: 570466 Telefax: (39.55)641257
Via Bartolini 29
20155 Milano Tel. 365083
La diffusione delle pubblicazioni OCSE viene assicurata dalle principali librerie ed anche da:
Editrice e Libreria Herder
Piazza Montecitorio 120
00186 Roma Tel. 679.4628
Telex: NATEL I 621427

Libreria Hoepli
Via Hoepli 5
20121 Milano Tel. 865446
Telex: 31.33.95 Telefax: (39.2)805.2886

Libreria Scientifica
Dott. Lucio de Biasio "Aeiou"
Via Meravigli 16
20123 Milano Tel. 807679
Telefax: 800175

Japan – Japon
OECD Publications and Information Centre
Landic Akasaka Building
2-3-4 Akasaka, Minato-ku
Tokyo 107 Tel. 586.2016
Telefax: (81.3)584.7929

Korea – Corée
Kyobo Book Centre Co. Ltd.
P.O. Box 1658, Kwang Hwa Moon
Seoul Tel. (REP)730.78.91
Telefax: 735.0030

Malaysia/Singapore – Malaisie/Singapour
University of Malaya Co-operative Bookshop Ltd.
P.O. Box 1127, Jalan Pantai Baru 59100
Kuala Lumpur
Malaysia Tel. 756.5000/756.5425
Telefax: 757.3661

Information Publications Pte. Ltd.
Pei-Fu Industrial Building
24 New Industrial Road No. 02-06
Singapore 1953 Tel. 283.1786/283.1798
Telefax: 284.8875

Netherlands – Pays-Bas
SDU Uitgeverij
Christoffel Plantijnstraat 2
Postbus 20014
2500 EA's-Gravenhage Tel. (070)78.99.11
Voor bestellingen: Tel. (070)78.98.80
Telex: 32486 stdru Telefax: (070)47.63.51

New Zealand – Nouvelle-Zélande
Government Printing Office
Customer Services
P.O. Box 12-411
Freepost 10-050
Thorndon, Wellington
Tel. 0800 733-406 Telefax: 04 499-1733

Norway – Norvège
Narvesen Info Center – NIC
Bertrand Narvesens vei 2
P.O. Box 6125 Etterstad
0602 Oslo 6
Tel. (02)67.83.10/(02)68.40.20
Telex: 79668 NIC N Telefax: (02)68.19.01

Pakistan
Mirza Book Agency
65 Shahrah Quaid-E-Azam
Lahore 3 Tel. 66839
Telex: 44886 UBL PK. Attn: MIRZA BK

Portugal
Livraria Portugal
Rua do Carmo 70-74
1117 Lisboa Codex Tel. 347.49.82/3/4/5

Singapore/Malaysia
Singapour/Malaisie
See "Malaysia/Singapore"
Voir "Malaisie/Singapour"

Spain – Espagne
Mundi-Prensa Libros S.A.
Castello 37, Apartado 1223
Madrid 28001 Tel. (91) 431.33.99
Telex: 49370 MPLI Telefax: 575.39.98

Libreria Internacional AEDOS
Consejo de Ciento 391
08009 -Barcelona Tel. (93) 301-86-15
Telefax: 575.39.98

Sweden – Suède
Fritzes Fackboksföretaget
Box 16356, S 103 27 STH
Regeringsgatan 12
DS Stockholm Tel. (08)23.89.00
Telex: 12387 Telefax: (08)20.50.21
Subscription Agency/Abonnements:

Wennergren-Williams AB
Box 30004
104 25 Stockholm Tel. (08)54.12.00
Telex: 19937 Telefax: (08)50.82.86

Switzerland – Suisse
OECD Publications and Information Centre
4 Simrockstrasse
5300 Bonn (Germany) Tel. (0228)21.60.45
Telex: 8 86300 Bonn
Telefax: (0228)26.11.04

Librairie Payot
6 rue Grenus
1211 Genève 11 Tel. (022)731.89.50
Telex: 28356

Maditec S.A.
Ch. des Palettes 4
1020 Renens/Lausanne Tel. (021)635.08.65
Telefax: (021)635.07.80

United Nations Bookshop/Librairie des Nations-Unies
Palais des Nations
1211 Genève 10
Tel. (022)734.60.11 (ext. 48.72)
Telex: 289696 (Attn: Sales)
Telefax: (022)733.98.79

Taiwan – Formose
Good Faith Worldwide Int'l. Co. Ltd.
9th Floor, No. 118, Sec. 2
Chung Hsiao E. Road
Taipei Tel. 391.7396/391.7397
Telefax: (02) 394.9176

Thailand – Thaïlande
Suksit Siam Co. Ltd.
1715 Rama IV Road, Samyan
Bangkok 5 Tel. 251.1630

Turkey – Turquie
Kültur Yayinlari Is-Türk Ltd. Sti.
Atatürk Bulvari No. 191/Kat. 21
Kavaklidere/Ankara Tel. 25.07.60
Dolmabahce Cad. No. 29
Besiktas/Istanbul Tel. 160.71.88
Telex: 43482B

United Kingdom – Royaume-Uni
H.M. Stationery Office
Gen. enquiries Tel. (071) 873 0011
Postal orders only:
P.O. Box 276, London SW8 5DT
Personal Callers HMSO Bookshop
49 High Holborn, London WC1V 6HB
Telex: 297138 Telefax: 071.873.8463
Branches at: Belfast, Birmingham, Bristol, Edinburgh, Manchester

United States – États-Unis
OECD Publications and Information Centre
2001 L Street N.W., Suite 700
Washington, D.C. 20036-4095
Tel. (202)785.6323
Telex: 440245 WASHINGTON D.C.
Telefax: (202)785.0350

Venezuela
Libreria del Este
Avda F. Miranda 52, Aptdo. 60337
Edificio Galipan
Caracas 106
Tel. 951.1705/951.2307/951.1297
Telegram: Libreste Caracas

Yugoslavia – Yougoslavie
Jugoslovenska Knjiga
Knez Mihajlova 2, P.O. Box 36
Beograd Tel. 621.992
Telex: 12466 jk bgd

Orders and inquiries from countries where Distributors have not yet been appointed should be sent to: OECD Publications Service, 2 rue André-Pascal, 75775 Paris Cedex 16.

Les commandes provenant de pays où l'OCDE n'a pas encore désigné de distributeur devraient être adressées à : OCDE, Service des Publications, 2, rue André-Pascal, 75775 Paris Cedex 16.

OECD PUBLICATIONS, 2 rue André Pascal, 75775 PARIS CEDEX 16 - No. 74419 1990
PRINTED IN FRANCE

3/90